SIEMENS

SIMATIC FS600 Laser Scanner

Laser Scanner for Personal Protection and Measurement Tasks

Instruction Manual

CE

Warning

The SIMATIC FS600 Laser Scanners are designed to protect operators working at or in the vicinity of dangerous machinery. They can only fulfill their protective requirements if they are installed to a suitable machine. It is therefore vital that you fully understand the information provided in this instruction manual and in all documents mentioned herein before any installation attempt. For any question please refer to your local SIEMENS dealer.

Important

This instruction manual must accompany the product throughout its working life. Those persons responsible for the product must ensure that all persons involved in the installation, commissioning, operation, maintenance and servicing on the product have access to all the information supplied by the manufacturers of the machine and its safety system.

Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ **DANGER**
indicates that death or severe personal injury will result if proper precautions are not taken.

⚠ **WARNING**
indicates that death or severe personal injury may result if proper precautions are not taken.

⚠ **CAUTION**
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by qualified personnel. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

> ⚠ **WARNING**
>
> This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

Trademarks

All names identified by ® are registered trademarks of the Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

About this Instruction Manual

This instruction manual contains information on the proper use and effective application of the SIMATIC FS600 Laser Scanner.

⚠ **WARNING**
All the information contained herein, in particular the safety notes, need to be carefully observed.

Notes regarding safety and warnings are marked by this symbol ⚠.

Notes regarding important pieces of information are marked by the symbol ⓘ.

References to the safety of laser devices are identified with the symbol .

This instruction manual must be stored carefully. It must be available for the entire operating time.

SIEMENS AG is not liable for damages caused by improper use. Knowledge of this instruction manual is an element of proper use.

	⚠ **Warning**
	Dangerous electric voltage! Electric voltage can cause electric shock and burns. Before commencement of work you therefore need to turn the system/device power off.

Important note

Safe device operation can only be guaranteed when certified components are used! The products described herein were developed to take over safety-related functions as part of a turn key system or machine. A complete safety-related system is usually equipped with sensors, evaluation units, status controls and incorporates concepts for safe switch-off procedures. It is the responsibility of the manufacturer of a system or a machine to ensure its correct overall operation. SIEMENS AG, its local offices and associated companies (hereafter referred to as “SIEMENS”) cannot guarantee for all features of a turn key system or a machine that was not designed by SIEMENS.
Neither does SIEMENS assume liability for recommendations given in or implied in the following instruction manual. The following instruction manual shall not be construed as a new guarantee, warranty or liability claim beyond the general terms and conditions of SIEMENS.

Copyright © SIEMENS AG 2007 All rights reserved

Reprints and reproduction of this instruction manual as well as communication and utilization of its content is not permitted without express permission. Noncompliance will entail compensation for damages. All rights reserved, in particular for the grant of patents or design registrations.

Technical Support:
Telephone:+49 (0) 180 50 50 222
Internet:www.siemens.com/automation/service&support

Subject to change without prior notice.

CONTENTS

1 Approvals and Certificates 10

1.1 Approval and Declaration of EC Conformity 10
1.2 Specialized Technical Terms and Abbreviations 11
1.3 Guidelines and Standards 12

2 System Overview 13

2.1 Brief Description and Functional Principle of the SIMATIC FS600 Laser Scanner 13
2.2 Special Features of the SIMATIC FS600 Laser Scanner 15

3 Safety notes and usage in accordance with intended purpose 17

3.1 General safety notes 17
3.2 Usage requirements and usage in accordance with intended purpose 17
3.3 Restrictions for Use 18
3.4 Information Related to Detection Zone Changeover 19
3.5 General information related to determining detection zone contours 20
3.6 Additional Safety Notes for Stationary Use 21
3.7 Additional Safety Notes for Mobile Use 22

4 Applications for the SIMATIC FS600 Laser Scanner 23

4.1 Stationary Safeguarding of the Danger Area 23
4.2 Access guarding by passage monitoring 24
4.3 Safeguarding of danger points based on hand and arm detection 25
4.4 Mobile Safeguarding of Automatic Guided Vehicles 26
4.5 Protecting Transporter Trolleys against Collisions 26
4.6 Guarding the sides on AGVs 27
4.7 Other possible applications 28

5 Information for Planning and Mounting 29

5.1 Attachment and Dimensions 30
5.2 Installing adjacent laser scanners 30
5.2.2 Adjusting adjacent laser scanners 31
5.3 Information on Setting the Dimensions of Detection Zones 32
5.3.1 Methods of Configuring Detection Zones using the PC 32
5.3.2 Range of the Detection Zone, Resolution 33
5.3.3 Range of the Warning Zone, Resolution 33
5.3.4 Range of the measurement field 34
5.3.5 Required Detection Zone Additions Z 34
5.4 Safeguarding Stationary Danger Zones 35
5.4.1 The Purpose of Safeguarding 35
5.4.2 Mounting Position 35
5.4.3 Mounting Height 36
5.4.4 Recommendations for Mounting to Prevent Unmonitored Zones 36
5.4.5 Additions 40
5.4.6 System Availability 40
5.4.7 Restart Interlock 41
5.4.8 Calculating the Detection Zone Dimensions for Safeguarding an Area 42
5.5 Access protection 47
5.5.1 Object of protection 47
5.5.2 Installation position 47
5.5.3 Safety-relevant settings, and calculation of the safety distance 47
5.5.4 Definition of the reference boundary 48

5.6 Protecting danger points ... 49
5.6.1 Object of protection ... 49
5.6.2 Installation position ... 49
5.6.3 Safety-related settings, and calculation of the safety distance ... 49
5.6.4 Defining the reference boundary ... 51
5.7 Safeguarding Mobile Machines ... 52
5.7.1 The Purpose of Safeguarding ... 52
5.7.2 Installing adjacent laser scanners ... 52
5.7.3 Mounting Position ... 52
5.7.4 Mounting Height ... 52
5.7.5 Recommendations for Mounting to Prevent Unmonitored Zones ... 53
5.7.6 Additions ... 55
5.7.7 System Availability ... 56
5.7.8 Restart ... 56
5.7.9 Calculating the Dimensions of the Detection Zone of an AGV Application ... 57
5.7.10 Side guarding configuration on AGVs ... 60

6 Details on switching over detection and warning zones ... 61

6.1 Sequence of zone pair switchovers ... 61
6.2 Practical AGV Application (Example) ... 63

7 Functions of the SIMATIC FS600 Laser Scanner ... 66

7.1 Restart ... 66
7.2 Channels for Zone Pair Changeovers, FP 1 to FP 4 ... 66
7.3 Alarm 1 (X1-5) ... 67
7.4 Alarm 2 (X1-15) ... 67
7.5 OSSD 1 (X1-12) and OSSD 2 (X1-11) ... 68
7.6 Data Communication ... 68

8 Integrating the SIMATIC FS600 Laser Scanner into Machine Controls ... 68

8.1 Integrating the SIMATIC FS600 Laser Scanner with External Wiring with Relays and Quadruple Zone Pair Changeover ... 69
8.2 Connecting the SIMATIC FS600 Laser Scanner to a Safety Sequence Circuit with Manual Restart, Relay Monitoring, without Zone Pair Changeover ... 71
8.3 Connecting the SIMATIC FS600 Laser Scanner to a PLC with Corresponding Safety Level (Cat. 3 or higher, EN 954) and Zone Pair Changeover ... 72

9 Electrical connection ... 73

9.1 Electrical Power Supply ... 73
9.2 Connecting the PC and Control Cables to the Scanner ... 73
9.3 Connector Assembly ... 74
9.4 Points to Consider When Preparing and Laying the Cables ... 74
9.5 Interface Pin Assignments ... 75

10 Commissioning ... 77

10.1 Hardware and Software Requirements ... 77
10.2 Installing “SIMATIC FS600 Parameterization Software LS4soft” and Starting Up the SIMATIC FS600 Laser Scanner ... 77
10.3 SIMATIC FS600 Laser Scanner status indicator ... 79
10.4 Status information of the SIMATIC FS600 Laser Scanner ... 81
10.5 Restart and device swap-out ... 82

11 Maintenance and Testing ... 83
11.1 Test before First Startup by Person Qualified and Authorized to Perform the Task ... 83
11.2 Extended Shutdown of the SIMATIC FS600 Laser Scanner ... 83
11.3 Regular Tests by a Person Qualified and Authorized to Perform the Task ... 84
11.4 Daily Test by with Test Piece Performed by Responsible Operating Personnel ... 84
11.4.1 Checklist for Daily Test of Stationary Applications by Responsible Operating Personnel ... 85
11.4.2 Checklist for Daily Test of Mobile Applications by Responsible Operating Personnel ... 86
11.5 Checklist for Testing Stationary Applications ... 87
11.6 Checklist for Testing Mobile Applications ... 89
11.7 Replacing the Optical Window ... 91
11.7.1 General information: ... 91
11.7.2 Initial Measurement of the New Optical Window ... 93
11.7.3 Procedure when Using the SIMATIC FS600 Parameterization Software LS4soft User Software Version 1.09 or later ... 94
11.8 Cleaning ... 95
11.8.1 Cleaning the Optical Window when Dirty ... 95
11.8.2 Cleaning the Optical Window; Cleaning Diffusing Light Panes ... 96

12 Disposal ... 97

13 Delivery Package ... 97
13.1 Coding of the Control Cable X1 ... 98

14 Technical data ... 99
14.1 Test Pieces ... 99
14.2 Detection zone ... 99
14.3 Detection Zone Additions ... 100
14.4 Warning zone ... 100
14.5 Contour Measurement ... 100
14.6 Electrical Power Supply ... 101
14.7 Inputs ... 101
14.8 Outputs ... 101
14.9 Software ... 102
14.10 Interfaces ... 102
14.11 Optics ... 102
14.12 Environment and Material ... 103
14.13 Dimensional drawings of the SIMATIC FS600 Laser Scanner ... 104
14.14 Dimensional drawings of the mounting system ... 105

15 Diagnostic Codes and Causes ... 106

1 Approvals and Certificates

1.1 Approval and Declaration of EC Conformity

EC prototype testing in accordance with
DIN EN 61496 - 1 and
IEC 61496 - 3

TÜV
PRODUCT SERVICE GMBH
IQSE
Ridlerstr. 65
80339 Munich

1.2 Specialized Technical Terms and Abbreviations

AGV	Automatic Guided Vehicle (FTS in German)
AOPD	Active Optoelectronic Protective Device
AOPDDR	Active Optoelectronic Protective Device responsive to Diffuse Reflection
BWS	See ESPE
EDM	External Device Monitoring Monitoring of external control parts (relay monitoring)
ESPE	Electro-Sensitive Protecting Equipment
FTS	Automatic Guided Vehicle (see AGV)
N.O.	Normal open contact
OSSD	Output Signal Switching Device Safety-relevant switch output
PC	Personal Computer
DZ	Detection Zone, German SF
Reset	Defined Reset of SIMATIC FS600 Laser Scanner
RS 232	RS 232 interface
RS 422	RS 422 interface
ZP	Zone pair (contains 1 x detection zone and 1 x warning zone), German FP
WZ	Warning Zone, German WF

Table 1.2-1: Specialized Technical Terms and Abbreviations

1.3 Guidelines and Standards

The following guidelines and standards are of critical importance for the implementation of laser scanners. Guidelines providing particularly relevant information for users of such systems are marked with an asterisk (*).

Guideline/Standard	Designation	
European Guidelines		
98 / 37 / EG	Machine guideline	
73 / 23 / EWG	Low voltage guideline	
89 / 336 / EWG	EMC guideline	
A Standards		
DIN EN 292 1 and 2	Safety of machinery, basic concepts	
DIN EN 1050	Principles of risk assessment	*
B1 Standards		
DIN EN 294	Safety distances	*
DIN EN 954 -1	Safety-related parts of controls	
DIN EN 999	Approach speeds of body parts	*
B2 Standards		
DIN EN 60204 -1	Electrical equipment of machines	
DIN EN 60825 -1	Safety of machines with laser components	
DIN EN 61496 -1	Electro-sensitive protecting equipment	*
IEC 61496-3	AOPDs responsive to diffuse reflection (AOPDDR)	*
C Standards		
DIN EN 775	Industrial robots; safety	*
DIN EN 1525	Automatic guided vehicles (AGV) and their systems	*
DIN EN 12895	Floor conveyor vehicles, electromagnetic compatibility	

Guideline/Standard	Designation	
National Standards		
DIN 15185-2	Warehousing systems using rail-guided aisle conveyance vehicles	*

Table 1.3-1: Guidelines and Standards

This list does not claim to be complete. In certain cases, the concrete requirements of the application will necessitate the application of additional guidelines and standards! Copies of safety standards can be purchased from the Beuth Publishing Company in Berlin, Germany.

2 System Overview

2.1 Brief Description and Functional Principle of the SIMATIC FS600 Laser Scanner

The SIMATIC FS600 Laser Scanner is an optical distance sensor that takes two-dimensional measurements. It could also be referred to as an optical area radar device. The sensor uses a rotating deflecting unit to periodically emit light pulses within a working range of 190°.

If these pulses strike a person or an obstacle, the reflected light is received and evaluated by the SIMATIC FS600 Laser Scanner. The scanner calculates the precise coordinates of the person or object based on the travel time of the reflected light and the current angle of the deflecting unit. If the person or obstacle is within the bounds of a previously defined area called a detection zone, a safety-oriented switching function is performed. This switching function causes the semiconductor outputs to be switched off. The safety-oriented switching function cannot be reset until the detection zone is clear. Depending on the operating mode, the reset can be initiated either automatically or manually.

DZ = Detection zone, max. 2,15 m / 4 m
WF = Warning zone, max. 15 m
a = Maximum registration of measurement values, max. 50 m
b = Detection zone programmed in the SIMATIC FS600 Laser Scanner (example)
c = Warning zone programmed in the SIMATIC FS600 Laser Scanner (example)
d = Configurable detection zone and warning zone expansion (-5 °)
e = Configurable detection zone and warning zone expansion (+5 °)
f = Object in the detection zone

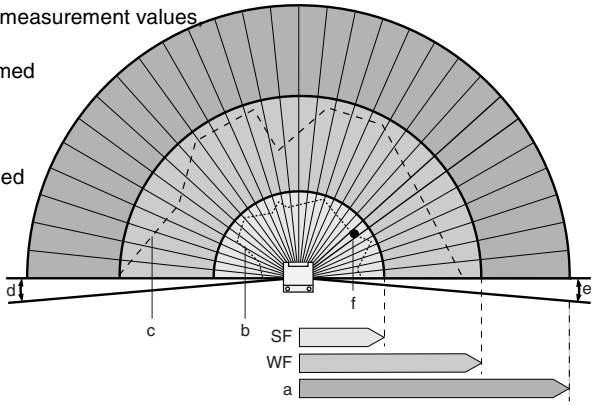


Fig. 2.1-1: The 190° angle range of the SIMATIC FS600 Laser Scanner is divided into 0.36° angle segments.

A laser diode coupled with transmitter optics produces focused light pulses. These pulses are projected across the monitored surface by a rotating mirror in such a way that a light pulse is triggered in each of the angle segments within 40 ms (scanning rate: 25 scans/s).

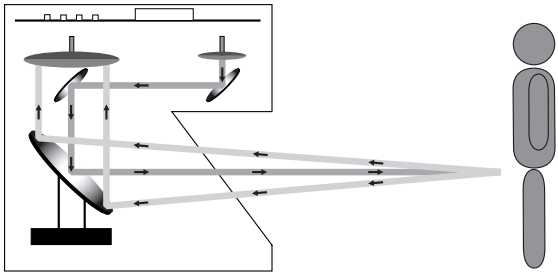


Fig. 2.1-2: Functional principle of the SIMATIC FS600 Laser Scanner

The SIMATIC FS600 Laser Scanner can detect people up to a distance of 4.0 m e.g. 2.15 m – even if they are wearing very dark clothing or exhibit a low degree of reflectance. Dangerous movements are brought to a standstill by two failsafe semiconductor outputs.

Objects (min. 150 x 150 mm) are detected up to a distance of 15 m (corresponds to the warning zone) and signaled by way of a non-safety-related semiconductor output.

Four programmable zone pairs (each of which consists of one detection zone and one warning zone) enable the scanner to be optimally adapted to the needs of each particular application.

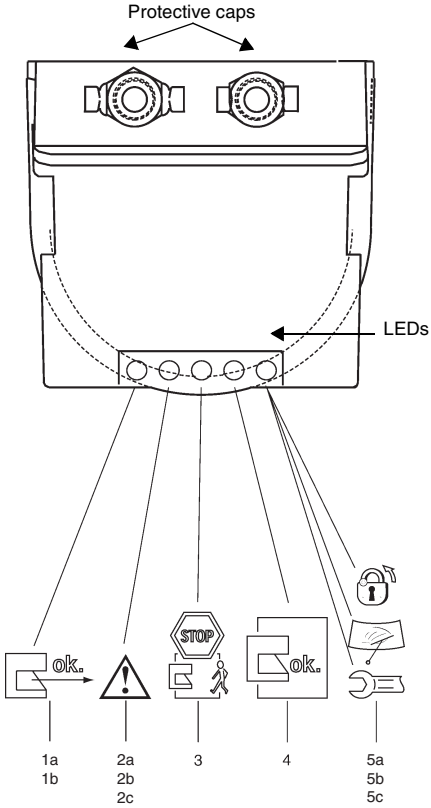
The SIMATIC FS600 Laser Scanner can be implemented not only on machines and systems (stationary safeguarding of danger zones), but also on vehicles (mobile safeguarding of transport vehicles).

Due to its wide range of measurement and its non-contact, electro-sensitive measurement principle,
the SIMATIC FS600 Laser Scanner can be effectively used as a protective device for virtually any application.

2.2 Special Features of the SIMATIC FS600 Laser Scanner

- Four / eight freely programmable detection zones (up to a maximum of 4 m)
- Four / eight freely programmable warning zones (up to a maximum of 15 m)
- Expanded monitoring range of up to 190 °
- ConfigPlug see Chapter 10.5 for **easy device swap-out without configuration expense**
- Compact design (W x D x H: 140 mm x 135 mm x 155 mm)
- Low weight (2 kg)
- Low power requirements (300 mA, plus the load at the outputs)
- Two types of interfaces at one Sub-D jack (RS232 and RS422)
- User-friendly software

Status displays on the SIMATIC FS600 Laser Scanner



1a= Sensor function

1b= Errors on the zone pair control inputs, Light flashing at 2 Hz

2a= Warning field is occupied

2b= Optical window is dirty, Light flashing at 2 Hz

2c= ConfigPlug configuration see Chapter 10.5 not compatible, Light flashing at 4 Hz

3 = OSSDs are turned off

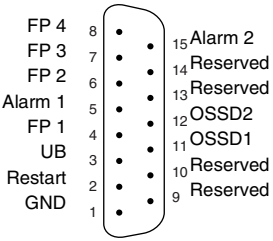
4 = OSSDs are turned on

5a= Restart inhibit locked, Continuous light

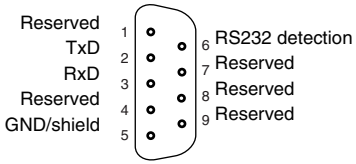
5b= Optical window is dirty, Light flashing at 2 Hz

5c= Fault, light flashing at 4 Hz

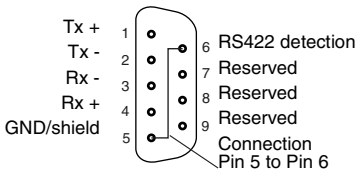
Assignment of interface X1



Assignment of interface X2 as RS232 port



Assignment of interface X2 as RS422 port



3 Safety notes and usage in accordance with intended purpose

3.1 General safety notes

SIEMENS products are developed and manufactured with careful application of standard rules of the industry. The protective function of the devices can be negatively affected, however, if they are used improperly or not in accordance with their intended purposes. If this occurs, it may not be possibly to safeguard danger areas completely or at all, which may result in danger to life and limb for persons who are in the general area of the machines or systems.

CAUTION – LASER RADIATION!
The SIMATIC FS600 Laser Scanner is a laser device belonging to laser class 1. The valid legal and local regulations for operating laser systems must be complied with. Avoid positioning the scanner at eye level.

3.2 Usage requirements and usage in accordance with intended purpose

The relevant regulations for machine safety apply for the use of the SIMATIC FS600 Laser Scanner. Responsible authorities (for example professional trade unions, OSHA) are also available for questions related to safety. In general, the following usage requirements must be observed:

- If the scanner is enclosed in a protective housing, additional window material, such as plastic or glass must not be used as it may impair the detection.
- Avoid touching the scanner optical window and the six diffusing light screens.
- The SIMATIC FS600 Laser Scanner is not suitable for use as a protective device:
  - if it is possible that dangerous fluids will be spewed out or objects will be
  - ejected. for machines with long braking times (max. depth of the detection zone: 4 m)
    For these cases, SIEMENS offers suitable safety interlocking devices (safety switches) with and without guard locking.
- The SIMATIC FS600 Laser Scanner corresponds to Type 3 in accordance with IEC 61496-1 and –3A safety category of 3 in accordance with EN 954-can be achieved with the SIMATIC FS600 Laser Scanner if all other elements in the safety chain are set up to stop the dangerous motion in accordance with that safety category.
- The electrical connection of the SIMATIC FS600 Laser Scanner to the control system must only be made by an electrician.
- The 24-V DC power supply (+20 %, -30 %) must be ensured by a safe network disconnect in accordance with IEC 742. The same requirements apply to all connected input and output circuits..

- The 24-V DC power supply must be fed to the scanner through a separate branch with a 1.25 Amp delayed action fuse in the control cabinet.
- Guard operation is only permitted with the control cable (X1) of the dummy connector . This also applies for transport and storage.
- The safety output has a double design. The two OSSDs must always be included in the shut-off circuit of the machine in such a manner that either of the two is completely sufficient by itself to turn off the motion that presents a danger.
- The alarm output 1 (Pin 5 on X1) must not be used to switch safety-related signals.
- System tests (of the scanner, machine, control components and switch components) may only be performed when they do not result in potential hazards for people.
- Tampering with or making changes to the SIMATIC FS600 Laser Scanner can result in the loss of the safety function.
- Only expert trained personnel is allowed to perform startup, maintenance, parameter settings or detection zone configurations. Familiarity with the safety notes in this Connecting and Operating Instruction and in the operating instructions for the “SIMATIC FS600 Parameterization Software LS4soft” program constitutes part of this expert knowledge.
- The password required for configuring safety-relevant parameters must be kept in a secure location by the safety official. Information about password levels can be found in the “SIMATIC FS600 Parameterization Software LS4soft” user's manual.
- If the machine is designed for start interlock /manual restart, all detection zones must be checked before enable - no one is permitted in the danger area.

3.3 Restrictions for Use

- Glass, highly reflective materials such as mirrors (reflectance > 10,000 %), or objects that do not reflect any light back to the sensor can falsify the measurement result. More information is available in Chapter 5.3.5.
- Do not expose the SIMATIC FS600 Laser Scanner to flying sparks (for example a welding flash). Doing so may cause damage to the optical window.
- Vapor, smoke, dust and all particles visible in the air have a significant negative effect on measurement values and will result in the semiconductor outputs being turned off.
- Avoid extreme variations in temperature.

- Make sure that the following types of light sources are not present on the scanning plane:
  - Laser light from one or more other scanners or sensors
  - Infrared light
  - Fluorescent light
  - Stroboscopic light

  Please consider as well Chapter 5.2.
- It must not be used with internal combustion engines.
- The SIMATIC FS600 Laser Scanner is conceived for use inside enclosed spaces and with the operating parameters listed in the technical specifications (temperature, humidity, shock, vibration, etc.). Please refer to the list of parameters in Chapter 14.
- Avoid having reflective surfaces (such as glass, mirrors, retro-reflectors, etc.) at fixed contours in the scanning plane. If this is not possible, an additional detection zone must be provided.

3.4 Information Related to Detection Zone Changeover

If alternating operation is included in the design, and thus detection zone changeover, the activation and effect of the detection zone in question must match the alternating operating mode.

- The new detection zone must be activated before turning off the previous detection zone. The time at which the changeover is made must be based on a risk analysis.
- Braking paths, response and coast-down times must be taken into consideration (for example overlapping detection zones).
- A “Start interlock” function is provided.
- If the machine has a restart key, it must not be possible to operate it from inside the detection zones. All danger areas must be visible from the position of the button. Before releasing the start/restart interlock, all detection zones must be tested. No one is permitted inside the danger areas.
- There must be no unmonitored zones inside the danger areas.
- There must be no possibility for direct access to the danger area that shortens the necessary safety distance (use a protective grid, for example).
- The information on required detection zone additions in Chapter 5 must be observed.

3.5 General information related to determining detection zone contours

- Shadow effects (e.g. surfaces or areas located behind stationary objects) must be considered. As a rule, insufficient safeguarding must be adequately supplemented by further safety measures such as guard fences, light curtains, and the like!
- Access to the detection zone in the dangerous area is not permitted.
- When setting the dimensions of the detection zone, you must comply with the formulas cited in Chapters 5.4.8 and 5.7.9 ! Be sure to comply with higher-level machine standards (e.g. DIN EN 1525) if applicable.
  These contain individual specifications, for example, on points of access to the danger zone and, if applicable, detection zone additions that must be given special consideration.
  They also provide information on how to measure safety distances at machines.
- Detection zones with a radius smaller than 20 cm (at or close to the scanner) are not admissible. 20 cm is the preset minimum contour.
- When setting the dimensions of the detection zones, please comply with the maximum angle error stated in the technical specifications (Chapter 14.11).
- Needle-shaped detection zone contours are not permitted, since they do not ensure any protective effect. For additional information, please refer to the SIMATIC FS600 Parameterization Software LS4soft user software (Chapter entitled “Definition of Detection Zones”).
- Due to possible measurement errors, every detection zone has an additions area in which detection is not guaranteed under all conditions. Please consider as well Chapter 5.3.5. Read Chapter 5.4.6 and 5.7.7 for information on optimizing system availability.
- The required safety distances must be taken into account when making detection zone configurations. Safety distances are calculated according to formulas found in either the machine-specific C standards or the general B standards IEC 61496-3 in combination with DIN EN 999 (see Section 2 and 5 of the standard). Tolerance fields and/or additions
  (make sure to consider Chapter 5.4 and 5.7).
- After the detection zones have been set, make a printout of the following information:
  - Detection zone contour with the X and Y coordinates
  - Date
  - Serial number of the scanner
  - Name of the safety official
- When calculating the additions, be sure to consider whether the dust algorithm is deactivated or activated (see Chapter 5.3.5).

- When calculating the safety distances, be sure to consider all delay times, such as the response time of the scanner, response time of the control elements, and braking times and/or stopping times of the machine/system or AGV! Variations in delay time caused by factors such as reduced braking power must also be taken into consideration.
- The effectiveness of the switch-off function must be tested along the defined contour of the detection zone during the initial startup and subsequent to any changes made to a machine or system.
- The effectiveness of the switch-off function must be tested for the detection zone contours along the entire driving route during the initial startup and following any changes made to an AGV.
- In the event that there is insufficient room available to allow the full dimensions of a detection zone, for example because of the position of the scanner, additional safety measures (e.g. safety grids) must be installed.
- Following each definition of and change to the detection zones, the configuration must be checked to see whether the possibility of people standing in the danger zone as well as any barriers provided have been considered by an appropriate layout of the detection zone(s).

3.6 Additional Safety Notes for Stationary Use

- If the danger zone can be accessed from the side, and if the detection zone cannot be extended sufficiently in this direction, additional safety measures (e.g. safety fences) must be installed.
- We recommended marking the contour of the detection zone on the floor by painting a colored line or applying colored adhesive tape.
- Check the mounting regularly (in particular, the angle of inclination) in order to guarantee the reliability of detection.

3.7 Additional Safety Notes for Mobile Use

- There are additional requirements for the use of scanners on automatic guided vehicles (AGV) and transporter trolleys according to DIN EN 1525.
- If possible, expanded detection zones to each side should be provided in order to safeguard access from the side and directly in front of the vehicle.
- If is it not possible to completely safeguard the contour of the vehicle including its trailer and the dimensions of its load while making curves, additional protective devices such as switch strips must be attached to the side of the vehicle.
- There must be a minimum safety distance S_{AB} of 500 mm to the side of the vehicle on both sides. A one-sided minimum safety distance is admissible in certain exceptional cases. The specifications of DIN EN 1525 must be complied with.
- The basic value of the detection zone width for an AGV corresponds to the maximum vehicle width including the trailer and the dimensions of the load plus the detection zone additions Z_S. Furthermore, the greatest possible lateral shift of the AGV while making curves must be considered when defining detection zones.
- If the SIMATIC FS600 Laser Scanner is mounted on vehicles, the mounting (especially the angle of inclination), the vehicles' braking power, and if applicable, play in the vehicle guidance (the difference between the optimum and actual line of guidance) must be regularly checked in order to guarantee the reliability of detection.

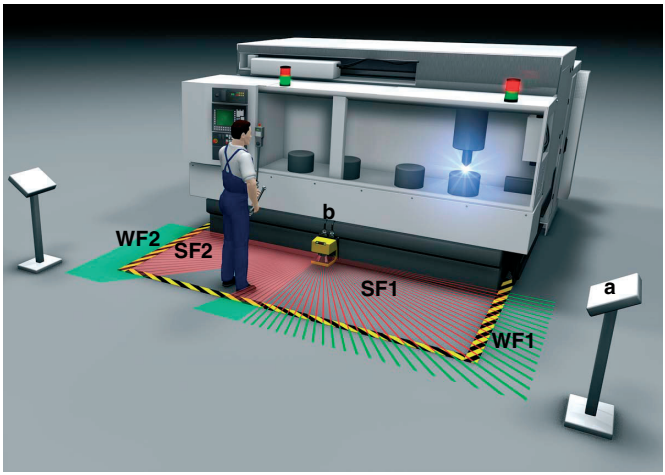
4 Applications for the SIMATIC FS600 Laser Scanner

Due to its continuous coverage of the area, its wide range, and the ability to select among four / eight zone pairs, the SIMATIC FS600 Laser Scanner is able to handle even complex applications

4.1 Stationary Safeguarding of the Danger Area

The SIMATIC FS600 Laser Scanner is used to safeguard dangerous working areas at machines and systems where both constant and variable demands are placed on the geometrical shape of the detection zone. The aim is to prevent people from entering the danger zone or reaching the danger point with their upper and/or lower extremities, at the same time without impeding the production process.

The SIMATIC FS600 Laser Scanner can be mounted directly at the machine table or on the side or in front of the machine.



SF1= Detection zone 1, activated

SF2= Detection zone 2, deactivated

WF1= Warning zone 1, activated

WF2= Warning zone 2, deactivated

a = Emergency stop and manual restart interlock

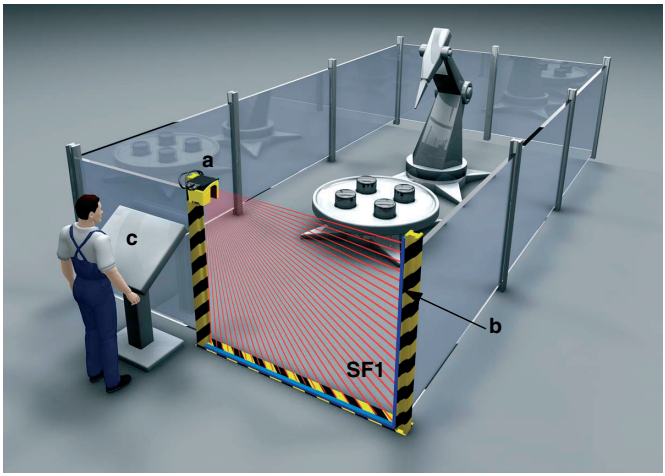
b = SIMATIC FS600 Laser Scanner

Fig. 4.1-1: Danger area guarding at stationary machinery with two alternating work areas

Please comply with the safety notes in Chapter 3 and Chapter 5.4.7. For an example of how to calculate detection zone measures, please refer to Chapter 5.4.8.

4.2 Access guarding by passage monitoring

Access guarding by passage monitoring (whole body trip control) is a suitable method when the access to a machine or to a hazardous zone can be precisely defined in structural terms, and there is no other unprotected access to the area. It is best to mount the laser scanner above the passage in question, in vertical alignment. In order to secure the protective equipment, laser scanner and fence against inadvertent misadjustment and manipulation, the detection zones of the SIMATIC FS660I Laser Scanner must be defined on the basis of a reference boundary. In this operating mode, the scanner will use the polled environment as a reference and so check for changes in the layout of the protective equipment, as well as checking every one of the individual measurements it carries out with a view to detecting an intrusion. An example of the configuration of the SIMATIC FS660I Laser Scanner to give access protection by passage monitoring will be found in Chapter 5.5.



a = SIMATIC FS660I Laser Scanner SF1 = Detection zone 1, enabled

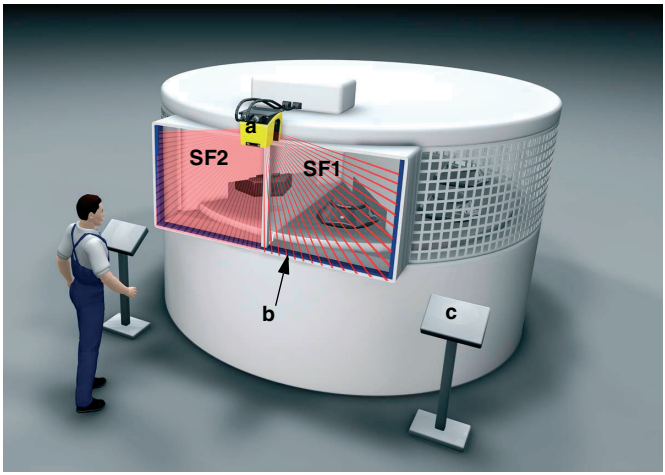
b = Reference boundary of the detection zone

c = Emergency stop and triggering of the manual restart interlock

Fig. 4.2-1: Access guarding by whole body trip control with system check of a reference boundary

4.3 Safeguarding of danger points based on hand and arm detection

If the machine operator, in close proximity to the danger zone, needs to halt the hazardous movement of the machine or to coordinate the handling of workpieces or their removal from the machine, the machine must be provided with protection at the danger point. To safeguard danger points in this way a protective system needs to be installed. The SIMATIC FS660I Laser Scanner is certified as a system providing hand and arm protection, and is able in such a situation to guarantee flexible safety conditions in the workplace. This may be combined with alternation of the detection zones. In order to safeguard the protective equipment, laser scanner and side-mounted panels (which serve as a reference and provide additional access protection) against inadvertent misadjustment or manipulation, the detection zones of the SIMATIC FS660I Laser Scanner must be defined on the basis of a reference boundary.
An example of the configuration of the SIMATIC FS660I Laser Scanner for the protection of danger points based on hand and arm protection may be found in Chapter 5.6.



a = SIMATIC FS660I Laser Scanner

b = Reference boundarys of the detection zones

SF1 = Detection zone 1, enabled

SF2 = Detection zone 2, disabled

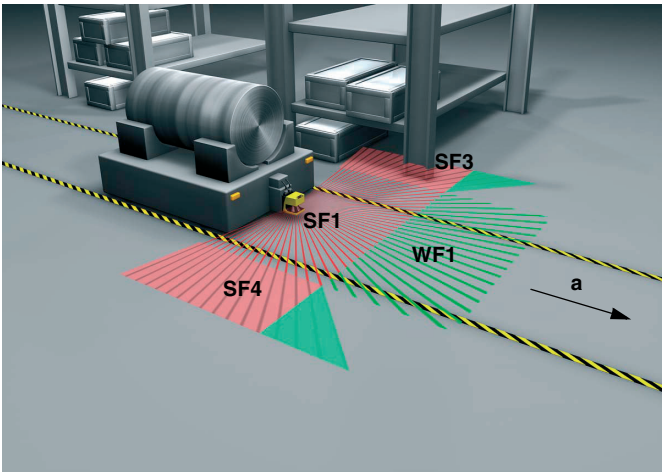
c = Emergency stop and manual triggering of restart interlock, acknowledgement for switchover

Fig. 4.3-1: Safeguarding of danger points based on hand and arm detection with alternation of detection zones

4.4 Mobile Safeguarding of Automatic Guided Vehicles

For this application, the SIMATIC FS600 Laser Scanner is installed on automatic guided vehicles in order to monitor the vehicle path. The aim is to detect people or objects in the path of the vehicle and to automatically bring the vehicle to a halt. Safety systems available up to now, such as bumpers or safety bars, have allowed only very low driving speeds to be maintained. In contrast, using the SIMATIC FS600 Laser Scanner as a non-contact “advance bumper” results in the creation of a substantially larger safety zone.

The vehicles can move faster, and down times are reduced to the necessary minimum.



SF1= Detection zone 1 for slow speed

WF1= Detection zone 2 for high speed

SF3= Detection zone 3 for a route curving to the left

SF4= Detection zone 4 for a route curving to the right

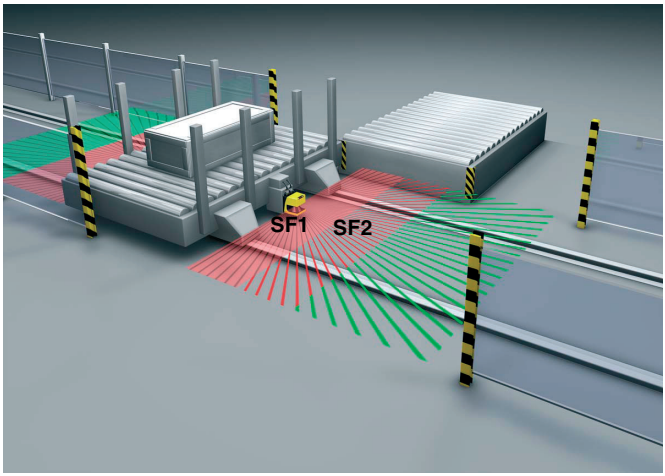
a = Traveling straight ahead

Fig. 4.4-1: Safeguarding an automatic guided vehicle

Please comply with the safety notes in Chapter 3. For an example of how to calculate detection zone measures, please refer to Chapter 5.7.9.

4.5 Protecting Transporter Trolleys against Collisions

Transporter trolleys are generally guided along a system of rails or grooves in the floor. Hence the vehicle paths are usually just slightly wider than the trolleys themselves. This represents an increased hazard for people, since it is impossible to get out of the way of the trolley. For this reason, transporter trolley are used in enclosed areas equipped with suitable access safeguarding.



SF1= Detection zone 1 for slow speed

SF2= Detection zone 2 for high speed

Fig. 4.5-1: Safeguarding a transporter trolley

Please comply with the safety notes in Chapter 3 and Chapter 5.7.8.
In these cases, the SIMATIC FS600 Laser Scanner is used to detect people or objects in the vehicle path and then automatically bring the vehicle to a halt. Select “Manual restart” mode.

The demands placed on the geometrical shape of the detection zone are determined by the vehicle width, speed, stopping distance and response time. Here as well, factors such as additions in the direction of travel for tolerances in the measurement value and reduced braking power due to wear and tear must be taken into consideration.

4.6 Guarding the sides on AGVs

In addition to the danger area guarding of the path of an AGV application, in some cases it is also necessary to set up a side guarding. This side guarding detects people in the space between vehicle and conveyor, or detects people that stand on the conveyor edge in the vehicle area. Furthermore, the side guarding also enables the correct position of the load to be monitored, so that a transport with overhanging load is not initiated.

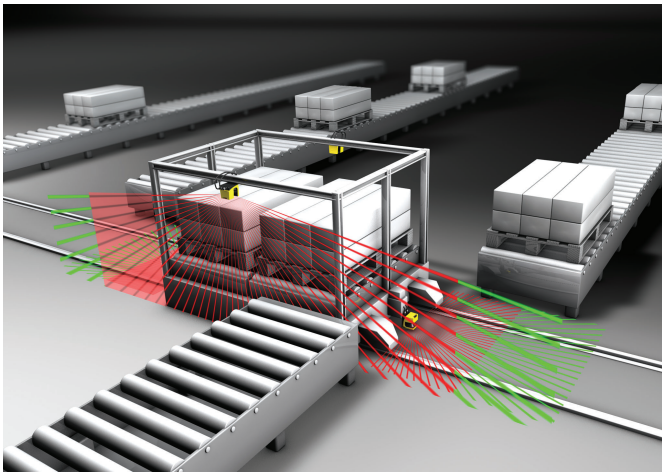


Fig. 4.6-1: Bild 6.3-1 Guarding the sides on AGVs

Please observe the safety notes in Chapter 3. An example for the side guarding configuration on AGVs can be found inChapter 5.7.9 and 5.7.10.

4.7 Other possible applications

- Object and contour measurement
- Logistics (counting, measuring, controlling)
- Projection control (e.g. in fully automatic parking ramps or lots)
- Safeguarding or monitoring enclosed spaces
- and many more

5 Information for Planning and Mounting

It is essential that the following key points be complied with so that the SIMATIC FS600 Laser Scanner can provide optimum performance:

- The SIMATIC FS600 Laser Scanner must be placed so that areas of access to the danger zone being monitored are completely covered by the detection zone.
- The mounting position of the scanner should provide protection from humidity, dirt and extreme temperatures below 0° C or over 50° C.
- The mounting position must be selected in such a way as to minimize the possibility of mechanical damage. Additional protective cover panels or safety bars must be installed at exposed positions.
- Reinforcements, cover panels, mounting niches, and other machine elements may not in any way impair the field of view of the scanner.
- If there are areas of shadow caused by fixed obstacles that were defined as part of the detection zone boundary, these should be safeguarded (e.g. by safety grids) in order to prevent people standing in them from being able to suddenly enter the detection zone. This point must be taken into account in the hazard analysis of the machine or system.
- Be sure that there are no retro-reflectors or highly reflective surfaces made of metal or ceramic in the area of the detection zone and at the height of the scanning plane. Such objects can cause measurement errors.
- In order to ensure a consistent detection height at every point of the detection zone, the scanner – and hence the scanning plane – must be placed parallel to reference section.
- If the “Restart interlock” function is included, the restart button must ne located outsidethe detection zone in a place that is visible from the entire danger area .
- If the scanner is used without a start interlock or startup test with automatic start/ restart, a startup warning (visual or acoustic) must be provided.
- The scanner must not be used as an aid for climbing. If there is is any risk, a suitable diagonal protection (45°) should be set up.

Please comply with the safety notes in Chapter 3, Chapter 5.4.7 and 5.7.8.

5.1 Attachment and Dimensions

For attaching the SIMATIC FS600 Laser Scanner, four drill holes are located at the back of the unit. Any laser scanner installation point is possible with mounting. The SIMATIC FS600 Laser Scanner can, for example, also be mounted on the head or inclined facing down.
The mounting set 3RG7838-1AA is available as an accessory offering following advantages:

- Speeds up the mounting process by providing screws that are accessible from the front.
- Allows vertical inclinations of up to 9°, either up or down, infinitely adjustable within this range.
- Allows lateral tilting of up to approx. 9° to either side from the midpoint setting, infinitely adjustable within this range.
- Enables quick replacement of the scanner without requiring realignment.

For information on which parts and dimensions are required for mounting, please refer to Chapter 14.13 and 14.14.

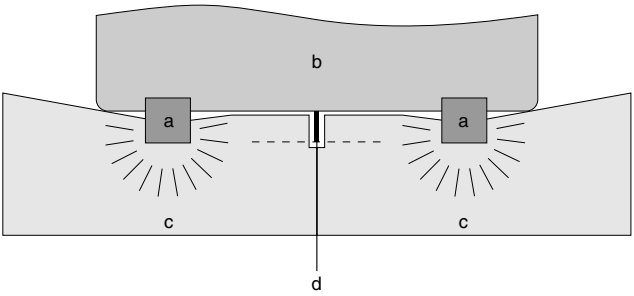
5.2 Installing adjacent laser scanners

The SIMATIC FS600 Laser Scanner has been developed in a way that prevents several laser scanners from interfering with one other as much as possible.

> ⚠ **WARNING**
>
> An increase in the response time can, however, be caused by the installation of several adjacent laser scanners. If **none** of the constructive measures (section 5.2.1) described in the following sections or the specific adjustment (section 5.2.2) are implemented, **then the SIMATIC FS600 Laser Scanner response time set and shown in the configuration and diagnosis software (SIMATIC FS600 Parameterization Software LS4soft) is extended by 40 ms.** This extension in the response time MUST be taken into account when calculating the safety distance!

5.2.1 Constructive measures

The direct external light irradiation from laser scanners of the same kind (905 nm laser light wavelength) in a line and at the same installation height can be prevented with shielding plates at scan level. Shielding, as high as the scanner front screen and flush with the front housing edge, is sufficient. The same also applies with installation in vertical alignment and overlapping of the scan levels.



a = SIMATIC FS600 Laser Scanner
b = Machine (view from above)
c = Detection zones
d = Shield plate, flush with the housing

Fig. 5.2-1: Shielding to prevent direct irradiation

5.2.2 Adjusting adjacent laser scanners

In order to prevent faulty deactivation and scanners interfering with each other as much as possible, when using several laser scanners you must install these as shown in the following examples. Installation on the basis of the 3RG7838-1AA installation system makes precise adjustment significantly easier.

Installation with height offset or a crossed alignment also prevents interference from beam reflections onto surrounding objects. When safeguarding danger zones, please also ensure that it is not possible to crawl under the protective field, so that gaps do not occur with access guarding..

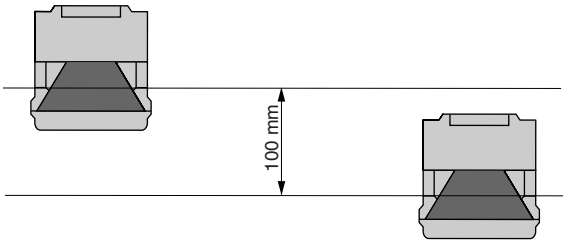


Fig. 5.2-2: Installation with height offset (parallel alignment)

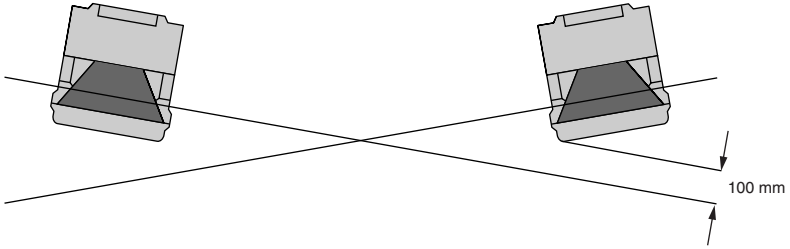


Fig. 5.2-3: Installation without height offset (crossed alignment)

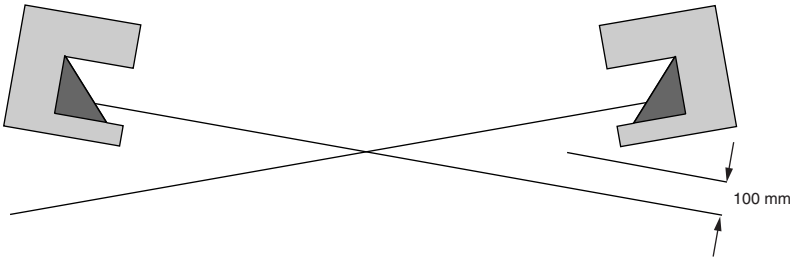


Fig. 5.2-4: Opposing installation without height offset (crossed alignment)

5.3 Information on Setting the Dimensions of Detection Zones

The hazards caused by machines and systems place a wide range of demands on safety distances and detection zones which must be appropriately defined.

5.3.1 Methods of Configuring Detection Zones using the PC

With its SIMATIC FS600 Parameterization Software LS4soft configuration and diagnostic software, the SIMATIC FS600 Laser Scanner offers various methods for setting the configurations of detection zones.

Numerical input

A separate dialogue within the user program “SIMATIC FS600 Parameterization Software LS4soft” allows the right, left and front edges of the detection zone to be set using numerical values in mm.

Graphic input

A separate dialogue within the user program “SIMATIC FS600 Parameterization Software LS4soft” allows the basic contours of the detection zone to be entered. The contours can be adapted infinitely to the desired size of the detection zone. The following shapes are available:

- circle
- rectangle
- polygon

In addition, the contours can be infinitely varied by:

- changing
- limiting and
- deleting

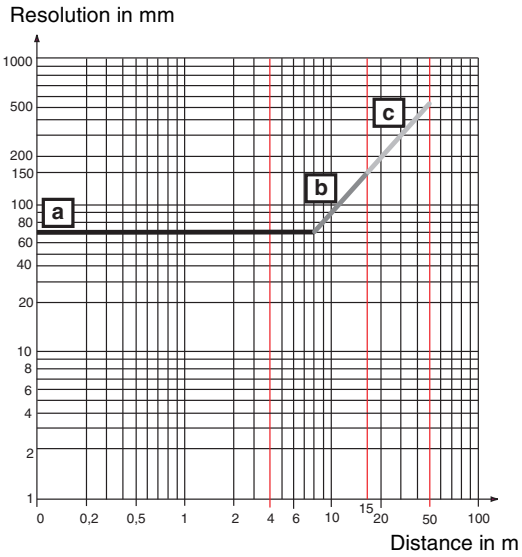
partial segments as desired

5.3.2 Range of the Detection Zone, Resolution

The maximum range of the detection zone S_{MAX} 4 m (including the additions) for an object with a diameter of 70 mm and a reflectance factor of 1.8 % (e.g. black corduroy). The reference point of the measurement is the axis of the rotating mirror on the scanner 64 mm behind the front edge of the scanner.

5.3.3 Range of the Warning Zone, Resolution

A maximum range of 10 meters is available for an object with a diameter of 100 mm. The maximum available range for an object with a diameter of 150 mm is
15 m. Both of these figures assume a reflectance factor of 20 %.

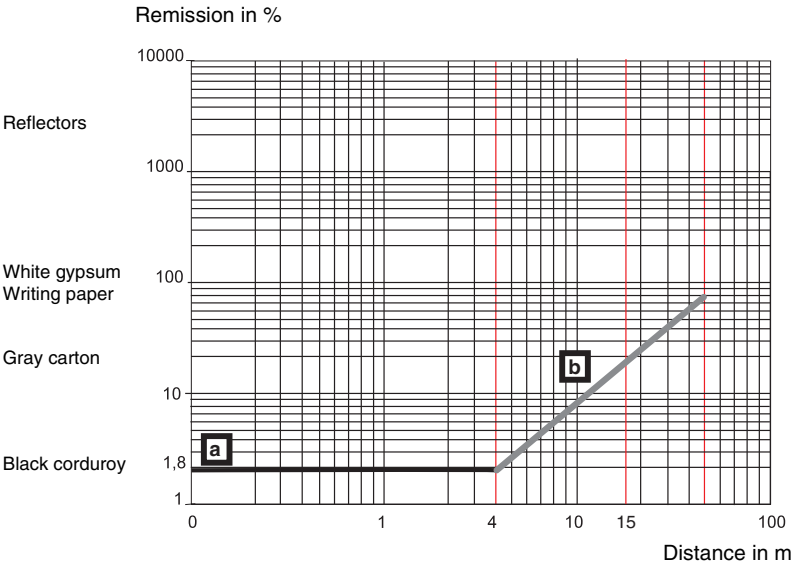


a = Detection zone
b = Warning zone
c = Measurement field

Fig. 5.3-1: Detecting objects in the detection zone and in the warning zone. The reference point of the distance measurement is the axis of the rotating mirror.

5.3.4 Range of the measurement field

The maximum distance for contour measurement at a reflectance factor of 80% (white gipsum) is 50 m.



a = Detection zone
b = Measurement field

Fig. 5.3-2: Detection of objects depending on the reflectance factor. The reference point of the distance measurement is the axis of the rotating mirror.

5.3.5 Required Detection Zone Additions Z

The SIMATIC FS600 Laser Scanner is equipped with a selectable dust algorithm to ensure optimum freedom from interference.

The following detection zone additions must be taken into account:

Addition Z_{SM} if dust suppression is deactivated	83 mm
Addition Z_{SM} if dust suppression is activated	83 mm (for a detection zone size < 3.5 m) 100 mm (for a detection zone size > 3.5 m)

Activation and deactivation of the function is performed by SIMATIC FS600 Parameterization Software LS4soft.

If retro-reflectors or very shiny surfaces, such as polished or enameled metals or ceramics, may possibly be present in the scanning plane, the following table applies:

Addition Z_{REFL} if retro-reflectors or very shiny, surface-treated materials (e.g. metals and ceramics) are present in the scanning plane	0 mm for reflectors more than 1.2 m behind the detection zone line 110 mm for reflectors up to 1.2 m behind the detection zone line

$$Z = Z_{SM} + Z_{REFL}$$

Z = Required detection zone addition, in mm
Z_{SM} = Measurement error of the scanner, in mm
Z_{REFL} = Addition for considering reflectors, in mm

5.4 Safeguarding Stationary Danger Zones

Please comply with the safety notes in Chapter 3.

5.4.1 The Purpose of Safeguarding

is for protection:

- to protect people when entering a danger zone
- to protect people from reaching a danger point with their extremities
- to protect objects from the danger of collision due to variable machine or part movements.

5.4.2 Mounting Position

The SIMATIC FS600 Laser Scanner can be mounted either in a stationary position (e.g. on a wall or a machine) or on moving parts (e.g. machine table).

The qualified installer must ensure that the mounting position of the SIMATIC FS600 Laser Scanner allows the danger zone to be monitored completely.

If a restart button is being used, make certain that the entire detection zone area can be viewed by the person pressing the button. It must not be possible to activate the button from the danger area.

Refer to the safety notes in Chapter 3.6 with regard to lateral access into the danger zone.

5.4.3 Mounting Height

According to DIN EN 999, the lowest admissible height of the scanning plane for people, as measured from the base level, is calculated according to the following formula:

$\mathbf{H_{MIN}}$ = 15 * (d **- 50 mm)**

H_{MIN} = Lowest admissible scanning plane from the base level
d = Resolution of the scanner in mm (object size = 70 mm throughout the detection zone).

The admissible height range of the SIMATIC FS600 Laser Scanner scanning plane lies between 0 mm (Presettings leg detection) and 1000 mm above the base level. If the application requires a scanning plane higher than 300 mm, or if children have access to the area, the analysis of the danger zone must consider the hazard caused by persons crawling below the scanning plane.

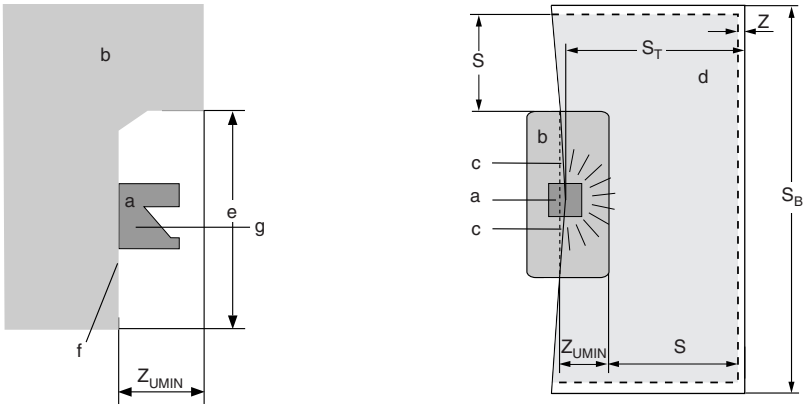
5.4.4 Recommendations for Mounting to Prevent Unmonitored Zones

Unmonitored zones can result if the scanner is mounted onto a protruding attachment or if the contour of the machine/system is varied in depth.

5.4.4.1 Recessed installation (undercut) under the machine table

The undercut must be at least as deep as the zone not monitored by the detection zone lateral to and in front of the scanner. The minimum depth Z_{UMIN} is 135 mm. If it is possible to recess the scanner, this is allowed up to a maximum of 40 mm; the depth of the undercut is reduced by the depth value of the recess. If the mounting system is being used, the necessary dimensions of the undercut depth must be increased accordingly (see Chapter 14.13 and 14.14). The height of the undercut must be limited to prevent people from being able to step beneath it.

Machine (side view) Machine (view from above)



a = SIMATIC FS600 Laser Scanner
b = Machine
c = unmonitored zone
d = Detection zone
e = Height of the undercut
f = Mounting surface
g = Scanning plane

S = Safety distance
S_B = Entire width of the
S_T = detection zone
Z = detection zone additions
Z_{UMIN} = depth of the undercut

Fig. 5.4-1: Recessed scanner installation with undercut

The additional safeguarding required for the particular application must be taken into account.

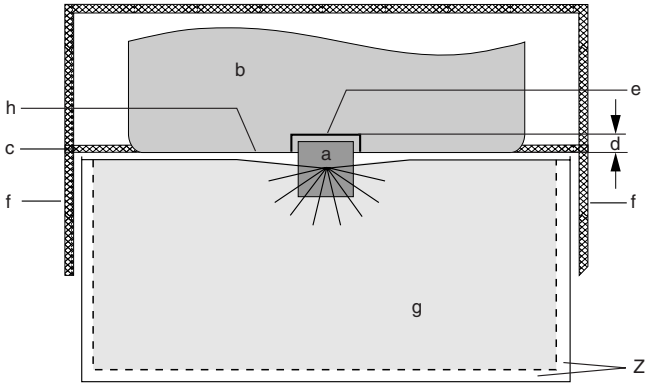
Please note that the undercut must cover any unmonitored zones.

5.4.4.2 Recessed installation within the machine contour

Furthermore, the scanner can be recessed into the contours of a machine. The recess can have a depth of up to 40 mm without the mounting system 3RG7838-1AA, or up to 65 mm with the mounting system 3RG7838-1AA. This is in reference to detection zones that cover an angle range of 180°. If it is not possible to comply with these values, or if unmonitored zones result due to the shape or movement of the machine, additional safety measures must be taken.

The effectiveness of the detection zones can be optimized by changing the depth at which the scanner is installed, or by adjusting the angle range (e.g. from 180° to 190°).

For information on how to configure the scanner in this way, please refer to the "SIMATIC FS600 Parameterization Software LS4soft" user's manual included with delivery.

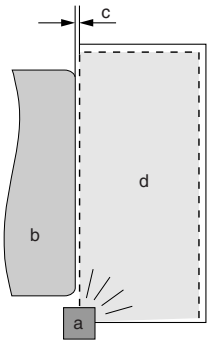


a	=	SIMATIC FS600 Laser Scanner	f	=	Lateral access safe guarding, if needed
b	=	Machine	g	=	detection zone
c	=	Lateral Access protection	h	=	Front machine edge
d	=	Maximum recessing (40 mm)	Z	=	Detection zone addition
e	=	Installation niche			

Fig. 5.4-2: Recessed installation within the machine contour

If it is not possible to mount the SIMATIC FS600 Laser Scanner directly onto the machine, it can also be positioned lateral to or across from the machine.

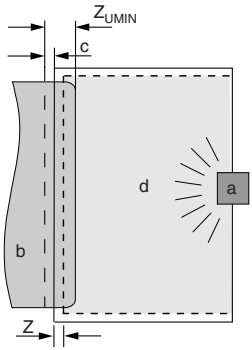
5.4.4.3 External mounting lateral to or across from the machine



a = SIMATIC FS600 Laser Scanner
b = Machine
c = Distance, max. 35 mm
d = Detection zone

Fig. 5.4-3: Lateral external scanner mounting without an undercut

If the machine contour runs parallel to the 90° beam of the laterally placed SIMATIC FS600 Laser Scanner, the distance between the detection zone boundary and the machine may not exceed 35 mm.



a = SIMATIC FS600 Laser Scanner
b = Machine
c = Minimum distance from the environment
d = Detection zone
Z = Required detection zone additions
Z_{UMIN} = Minimum depth of the undercut

Fig. 5.4-4: Mounting the scanner across from the machine with an undercut

5.4.5 Additions

The axis of the rotating mirror (midpoint of the scanner) is of critical importance when configuring the detection zones. This axis is assigned a value of 64 mm from the front edge of the scanner when calculating detection zones.

Add **83 mm** or **100 mm** for the maximum radial measurement error Z_{SM} as described in Chapter 5.3.5 .

Add an addition Z_{REFL} as described in Chapter 5.3.5 if reflectors could be present in the area.

Please note that safety additions must principally be added to the safety distance throughout the entire detection zone.
In other words, additions may not be added to just one side or only to certain sections.

Please consult the operating instructions provided by the machine or system manufacturer.

5.4.6 System Availability

There must be a buffer distance of 83 mm between the surrounding contour and the detection zone contour (including the additions). This distance increases the up-time of the machine or system since it prevents the surrounding contour from being detected as relevant for generating a switch-off signal. If there is an undercut across from the scanner that is impossible for a person to step beneath (see Fig. 5.4-4), the depth of the undercut can be calculated according to the following formula:

$$\mathbf{Z_{UMIN} = Z + 83\ mm - d}$$

Z_{UMIN} = Depth of the undercut, in mm
Z = Required detection zone additions, in mm
d = Resolution of the scanner (d = 70 mm)

This is possible since it is absolutely certain that a person will be detectedin front of the undercut .

Furthermore, the dust algorithm of the SIMATIC FS600 Laser Scanner can be implemented if floating particles may be present in the area. This algorithm, which can be activated in the user program “SIMATIC FS600 Parameterization Software LS4soft”, prevents the machine or system from being switched off unintentionally. Please note Chapter 5.3.5.

If the danger zone analysis allows a multiple evaluation, detection errors caused by floating particles can be decreased. The number of evaluations that is decisive for the response time of the scanner (T_{SCAN}), and thus also requires a larger detection zone, can be set in the user program “SIMATIC FS600 Parameterization Software LS4soft”.
In the event of an error event that lasts only briefly (for example the effect of extraneous light) the scanner performs a one-time reboot. If automatic startup and restart are activated, the scanner turns the OSSDs back on after this brief error event, and after the detection zone has been free for about 25 seconds. This one-time reboot results in an additional increase in availability. This function does not have any effect if detection zone activation is faulty. If startup test, startup interlock and / or manual restart are included, they will not be removed.

⚠ SAFETY NOTES
Automatic startup / restart must only be used in cases where there is absolutely no possibility that the effective detection zone could be entered or bypassed in some other way. Depending on the hazard assessment, visual and / or acoustic startup warnings should be provided.

If parameters are set for the function “Manual restart”, the required enable from the startup/restart button affects all detection zones and is independent of any detection zone changeover. If the current detection zone is manually enabled, this enable also applies even if the system switches to another detection zone and this detection zone becomes free! If startup/restart interlock is in effect in the current detection zone, it is also in effect for the other detection zone to which the system switches even if this detection zone is free.

5.4.7 Restart Interlock

The SIMATIC FS600 Laser Scanner is equipped with a restart interlock function. You can select or deselect this function as needed to connected restarting of the machine to a manual approval. It affects all detection zones and does not depend on any detection zone changeovers. For information on how to configure the scanner appropriately, please refer to SIMATIC FS600 Parameterization Software LS4soft (Section: “Safety-relevant parameters” folder)

The restart button must be mounted so that

- the entire danger zone (or detection zone area) can be viewed from the operating position.
- it is not possible to directly step or reach into the danger zone or danger point from the operating position.

The button refer to the areas to be enabled in a easily understandable manner.
Please comply with the safety notes in Chapter 3 and 5.4.6.

5.4.8 Calculating the Detection Zone Dimensions for Safeguarding an Area

According to **IEC 61496-3** and **DIN EN 999**, the following formulas apply for calculating the safety distance and the minimum depth of the detection zone when the direction of approach runs parallel to the detection zone:

S = (K x T) + C
C = 1200 mm – 0.4 H

C_{MIN} = 850 mm
H_{MIN} = 15 (d – 50 mm)
H_{MAX} = 1000 mm

S = Safety distance, minimum distance from the danger zone to the point of detection, to the plane of detection, or to the detection zone, in mm
K = Approach speed of a person or a person's body parts (1600 mm/s), in mm/s
T = Lag time of the entire system (response time and braking time until standstill), in s
C = Safety-related constant to consider entry into the danger zone before the protective device is triggered, in mm
C_{MIN} = Minimum value of the safety-related constant (850 mm), in mm
H = Height of the scanning plane from the reference point, in mm
H_{MIN} = Minimum height of the scanning plane from the reference plane, in mm
H_{MAX} = Minimum height of the scanning plane from the reference plane, in mm
d = Resolution of the scanner (70 mm throughout the detection zone), in mm

5.4.8.1 Additions and Minimum Depth of Detection Zone

The sum of the system-specific and application-specific detection zone additions (see Chapter 5.3.5) is calculated according to the following formula:

$$Z_{TOT} = Z_{SM} + Z_{REFL} + Z_{AU}$$

Z_{TOT} = Sum of the system-specific and application-specific detection zone additions, in mm
Z_{SM} = Scanner measurement error, in mm
Z_{REFL} = Addition of the reflectors taken into account, in mm

Z_{AU} = Addition for application-specific undercut, in mm

The depth of the detection zone, with reference to the direct distance between the danger zone and the detection point or line, is calculated according to the following formula:

$$S_T = (K \times (T_{SCAN} + T_{MACH} + (T_{LAG} \times L_{LAG}))) + C + Z_{TOT}$$

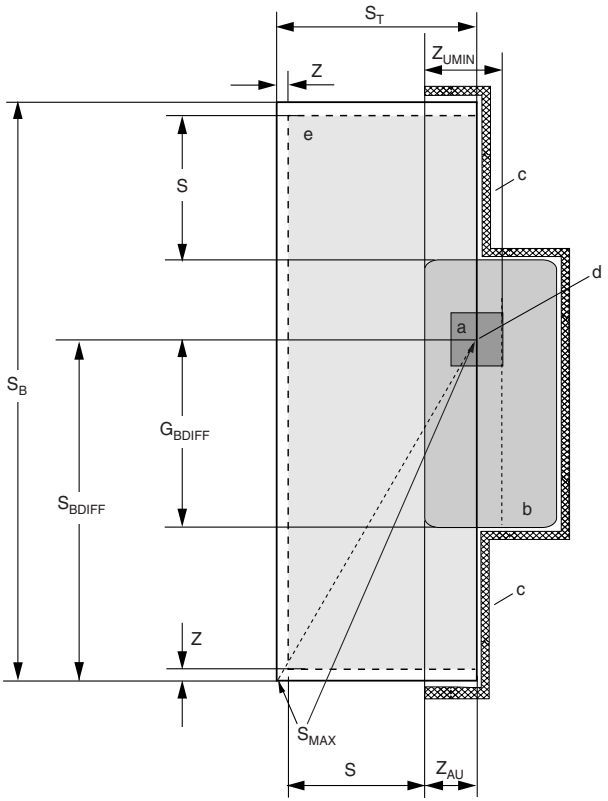
S_T = Depth of detection zone, distance from danger area to detection point or line, including system and application-specific additions, in mm
K = Approach speed of a person or a person's body parts (1600 mm/s), in mm/s
T_{SCAN} = Response time of the scanner, in s
T_{MACH} = Response time of the machine or system, in s
T_{LAG} = Lag time of the entire system, in s
L_{LAG} = Factor for increase in lag time
C = Safety-related constant, in mm

5.4.8.2 Maximum range of detection zone

$$S_{MAX} = \sqrt{S_T^2 + S_{BDIFF}^2}$$

$$S_{BDIFF} = G_{BDIFF} + S + Z$$

S_{MAX} = Maximum range of the detection zone considering the diagonals, in mm
S_T = Depth of the detection zone, in mm
S_{BDIFF} = Largest width of the detection zone between the axis of the rotating mirror and the outer edge of the detection zone, in mm
G_{BDIFF} = Largest width of the danger zone between the axis of the rotating mirror and the boundary of the danger zone, in mm
S = Safety distance, minimum distance from the danger zone to the point of detection, to the plane of detection, or to the detection zone, in mm
Z = Required detection zone additions, in mm



a = SIMATIC FS600 Laser Scanner
b = Dangerous machine/danger zone
c = Safety fence to prevent stepping behind
d = Axis of the rotating mirror
e = Detection zone
G_{BDIFF} = Largest width of the hazardous zone
S = Safety distance
S_B = Entire width of the detection zone
S_{BDIFF} = Largest width of the detection zone
S_{MAX} = Maximum geometrical distance
S_T = Depth of the detection zone
Z_{AU} = Detection zone addition, application-specific
Z = Detection zone additions
Z_{UMIN} = Undercut

Fig. 5.4-5: Considering the maximum measurement distance when safeguarding an area

5.4.8.3 Sample calculation of the depth of a detection zone

This example is based on the following application data (see 5.4-5):

Largest width between the axis of the rotating mirror and the boundary of the danger zone	G_{BDIFF}	700 mm
Access speed	K	1600 mm/s (constant)
Response time of the SIMATIC FS600 Laser Scanner (adjustable)	T_{SCAN}	0.08 s
Response time of the machine or system	T_{MACH}	0.1 s
Stopping time or lag time of the machine or system	T_{LAG}	0.5 s (time for braking the dangerous movement until standstill)
Factor for increase in lag time	L_{LAG}	1.1 (fixed addition to account for increased lag time)
Addition for system-specific measurement error	Z_{SM}	83 mm (when dust algorithm is switched off)
Addition caused by the mounting position that is selected	Z_{AU}	125 mm (distance between the front edge of the undercut to the beam axis of the scanner)
Height of the sensor scanning plane	H	300 mm
Safety-related constant	C	1200 mm – 0.4 * Height H = 1080 mm

The formula

$$\mathbf{S = (K \times (T_{SCAN} + T_{MACH} + (T_{LAG} \times L_{LAG}))) + C}$$

results in a safety distance of:

$$\mathbf{S = (1600\ mm/s * (0.08\ s + 0.1\ s + (0.5\ s * 1.1))) + 1080\ mm = 2248\ mm}$$

The formula

$$\mathbf{S_T = S + Z_{SM} + Z_{AU}}$$

results in the detection zone depth:

$$\mathbf{S_T = 2248\ mm + 83\ mm + 125\ mm = 2456\ mm}$$

5.4.8.4 Sample calculation of a maximum range of a detection zone

The formulas:

$$S_{MAX} = \sqrt{S_T^2 + S_{BDIFF}^2}$$

$$S_{BDIFF} = G_{BDIFF} + S + Z_{SM}$$

yield, under consideration of the width of the danger zone results in the maximum distance to be monitored:

$$S_{MAX} = \sqrt{2456\,mm^2 + 3031\,mm^2}$$

S_{BDIFF} = 700 mm + 2248 mm + 83 mm = 3031 mm

S_{MAX} = 3901 mm

5.4.8.5 Sample calculation of an undercut

This example is based on the following application data. If the scanner is mounted across from the machine (see Fig. 5.4-4), the undercut dimension can be reduced by **d** = 70 mm.

The formula

Z_{UMIN} = Z + 83 mm – d

results in a minimum undercut:

Z_{UMIN} = 83 mm + 83 mm – 70 mm = 96 mm

It is not allowed for a person to be able to step beneath the undercut.

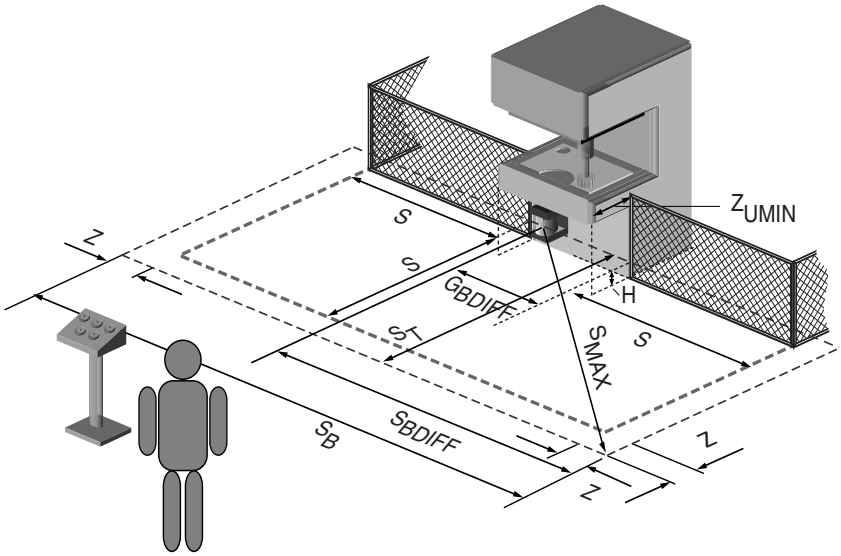


Fig. 5.4-6: The undercut

5.5 Access protection

Please have regard to the General Notes on Safety in Chapter 3.

5.5.1 Object of protection

The object of protection is the safeguarding

- of individuals when they access a danger zone.

The SIMATIC FS660I Laser Scanner will detect the passage of individuals and the intrusion of an entire human body into the scanning field of the laser scanner.

5.5.2 Installation position

Access protection is based on passage monitoring. This is a suitable system when the access to a machine or to a hazardous zone can be precisely defined in structural terms, and there is no other unprotected access to the area. In addition, the danger area must be open to inspection, and the button for manual triggering of the restart interlock must be situated outside the area. It is best if the laser scanner is firmly installed above the passage in question, in vertical alignment and in such a way that it cannot be manipulated. Care must be taken to ensure that the positioning of the SIMATIC FS660I Laser Scanner does not leave any areas through which a person might slip through without being detected. The distance of the scanning field limiting the passage and the boundaries of the detection zone must be defined in such a way that no gaps measuring more than 150 mm can arise.

5.5.3 Safety-relevant settings, and calculation of the safety distance

To safeguard the protective equipment against inadvertent misadjustment or manipulation, the detection zones of the SIMATIC FS660I Laser Scanner must be defined on the basis of a reference boundary. In addition, the response time must be defined as 80 ms and the restart interlock must be set. To enable the system to recognise an entire human body, the laser scanner must have a resolution of 150 mm. These safety-related settings will be automatically enabled in the SIMATIC FS600 Parameterization Software LS4soft configuration and diagnosis software when the presetting ”Passage monitoring” has been selected.

For effective passage monitoring, a safety distance S must be observed between the detection zone of the laser scanner and the danger zone. The SIMATIC FS660I Laser Scanner can fulfil its protective function only if it has been installed and positioned in such a way as to allow for an adequate safety distance. The safety distance ensures that no body part whatever can reach the danger point until the hazardous movement of the machine has come to a complete standstill.

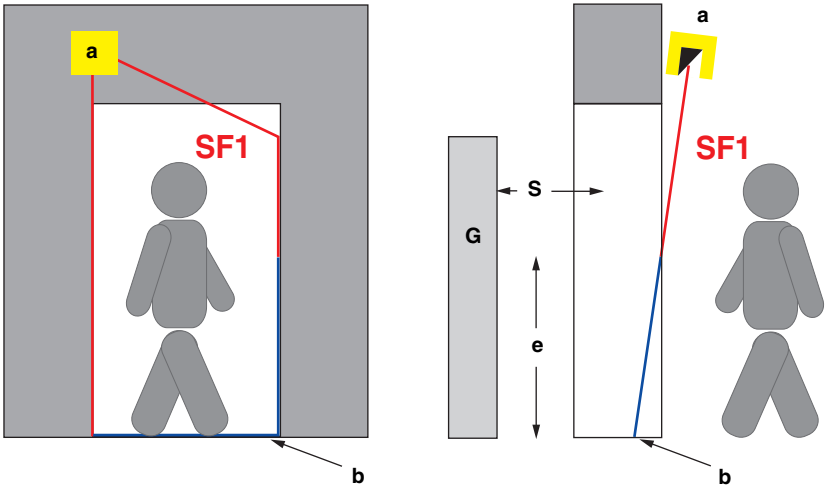
The safety distance for an access protection system may be calculated, based on EN 999, by means of the following formula:

$S = K \times T + C$

S	=	Safety distance in mm	
K	=	Approach velocity in mm/s	here = 1600 mm/s
T	=	Overall time of delay in seconds, a total consisting of:	
		Response time of the laser scanner	here = 80 ms
		Overtravel time of the machine including the controls	Based on measurement of overtravel time
C	=	Added margin on account of the possibility of manual intrusion	here = 850 mm

Please also have regard, in this connection, to the diagrams given in this chapter.

5.5.4 Definition of the reference boundary



a = SIMATIC FS660I Laser Scanner
b = Reference boundary of the detection zone
e = Height of frame with reference boundary; recommended value: e > 1200 mm
SF1= Detection zone 1, enabled
S = Safety distance
G = Danger zone

Fig. 5.5-1: Access protection by passage monitoring with system check of a reference boundary

The reference boundary must cover at least two sides of the detection zone. The detection zone itself must be defined in such a way that no gaps can arise through which a person could pass through the passage without being detected. The reference boundary is defined with reference to the non-moving parts of the passage. These will then be constantly monitored by the laser scanner, so that any individuals intruding or other manipulative intervention will be detected beyond the possibility of doubt. In defining the reference boundary, please also have regard to the indications given in the Operating Instructions for the SIMATIC FS600 Parameterization Software LS4soft configuration and diagnosis software.

5.6 Protecting danger points

Please have regard to the General Notes on Safety in Chapter 3.

5.6.1 Object of protection

The object of protection is the safeguarding

- of individuals who work with a machine or spend time in the danger zone associated with it.

The SIMATIC FS660I Laser Scanner will detect the body parts of individuals and the intrusion of these body parts into the scanning field of the laser scanner. In this operating mode, hand and arm protection is effectively realised.

5.6.2 Installation position

Safeguarding of danger points on the basis of hand and arm protection is a suitable method if the machine operator, in close proximity to the danger zone, needs to halt the hazardous movement of the machine or to coordinate the handling of workpieces or their removal from the machine. It is best if the laser scanner is firmly installed above the danger zone, in such a way that it cannot be manipulated. The health and safety officer must ensure that the installation position of the SIMATIC FS660I Laser Scanner does not leave any areas free through which manual intrusion could be effected. If appropriate, additional protective facilities should be installed to exclude any possibility of the operator's reaching over or around or getting behind the barrier. To prevent the latter, the distance from the scanning field to the machine table must not be more than 75 mm. This can be guaranteed if suitable screens are installed for the monitoring of the reference boundary (see the illustrations in this chapter).

5.6.3 Safety-related settings, and calculation of the safety distance

In order to safeguard the protective equipment against inadvertent misadjustment and manipulation, the detection zones of the SIMATIC FS660I Laser Scanner must be defined on the basis of a reference boundary. To make it possible to recognise the hand or arm of a person, the laser scanner must have a resolution of 30 or 40 mm. These safety-related values will be automatically set in the SIMATIC FS600 Parameterization Software LS4soft configuration and diagnosis software when the presetting "Hand protection" or "Arm protection" has been selected. At the same time the detection zone limits will be limited to 1.60 m or 2.20 m, and cannot be extended beyond this.

To safeguard the danger point, a safety distance S must be observed between the detection zone of the laser scanner and the danger zone. The SIMATIC FS660I Laser Scanner can fulfil its protective function only if it has been installed and positioned in such a way as to allow for an adequate safety distance. The safety distance ensures that no body part whatever can reach the danger point until the hazardous movement of the machine has come to a complete standstill.

The safety distance S when safeguarding a danger point may be calculated, based on EN 999, by means of the following formula:

$S = K \times T + C$

S = Safety distance in mm

K = Approach velocity in mm/s

At a close distance of 500 mm, a velocity of 2000 mm/s should be assumed. If the calculation involves a distance in excess of 500 mm, K may be taken to be 1600 mm/s. But in this case the safety distance is subject to a minimum value of 500 mm.

T = Overall time of delay in seconds, a total consisting of:

Response time of the laser scanner	Adjustable, max. 200 ms
Overtravel time of the machine including the controls	Based on measurement of overtravel time

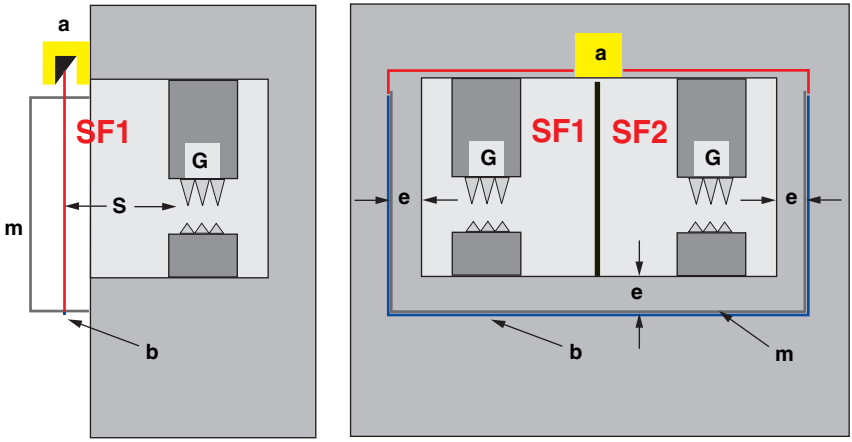
C = 8 x (d-14) in mm

Added margin dependent on the depth of penetration of the detection zone, based on the resolution of the laser scanner: C(30mm) = 128 mm, C(40mm) = 208 mm

d = The resolution to which the laser scanner has been set — Here = 30 mm or 40 mm

In this connection please also have regard to the illustrations given in this chapter.

5.6.4 Defining the reference boundary



a = SIMATIC FS660I Laser Scanner
SF1 = Detection zone 1, enabled
b = Reference boundary of the detection zone
SF2 = Detection zone 2, disabled
S = Safety distance
G = Danger point
m = Screen
e = Distance from the screen to the intrusion zone of the danger point, e > 150 mm (tolerance zone); the reference boundary must be defined with reference to the screen.

Fig. 5.6-1: Safeguarding of danger point based on hand and arm protection with monitoring of a reference boundary

The reference boundary must cover at least two sides of the detection zone. The detection zone itself must be defined in such a way that no gaps can arise through which or over which a person could reach without being detected. The detection zone must also provide safeguards against a person getting behind the barrier. This can be very effectively managed by screening the sides of the danger zone. The reference boundary should be defined with reference to the non-moving parts of the screen arrangement. The detection zone must be defined as large enough to ensure an overlapping greater than the tolerance zone of the reference boundary. The detection zone will then be constantly monitored so that any body parts intruding or other manipulative intervention will be detected beyond the possibility of doubt. In defining the reference boundary, please also have regard to the indications given in the Operating Instructions for the SIMATIC FS600 Parameterization Software LS4soft configuration and diagnosis software.

5.7 Safeguarding Mobile Machines

Please comply with the safety notes in Chapter 3.

5.7.1 The Purpose of Safeguarding

is for protection:

- to protect people when entering variable danger zones
- to protect objects located in the vehicle path
- to protect the automatic guided vehicle and its load

5.7.2 Installing adjacent laser scanners

The SIMATIC FS600 Laser Scanner has been developed in a way that prevents several laser scanners from interfering with one other as much as possible.

> ⚠ WARNING
>
> An increase in the response time can, however, be caused by the installation of several adjacent laser scanners. If **none** of the constructive measures (section 5.2.1) described in the following sections or the specific adjustment (section 5.2.2) are implemented, **then the SIMATIC FS600 Laser Scanner response time set and shown in the configuration and diagnosis software (SIMATIC FS600 Parameterization Software LS4soft) is extended by 40 ms.** This extension in the response time MUST be taken into account when calculating the safety distance!

5.7.3 Mounting Position

For the purpose of safeguarding the path of a vehicle, the SIMATIC FS600 Laser Scanner is mounted on the front of a vehicle (in each direction of travel), preferably in the center.

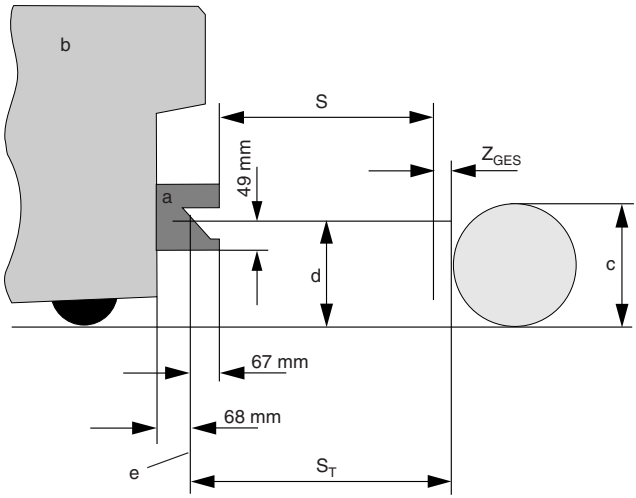
The scanner, and hence the beam axis, must be aligned horizontally in order to achieve a consistent scanning height.

Please comply with the safety notes in Chapter 3.7.

5.7.4 Mounting Height

As a rule, the scanner should be mounted as low as possible in order to prevent people from crawling beneath the detection zone. This specification is limited due to such factors as uneven floors or the deflection of the springs in the AGV.

The maximum mounting height must be selected so that an object (cylinder with a diameter of 200 mm in the prone position) is reliably detected (see DIN EN 1525). The detection must be tested at the position of maximum depth within the detection zone. For AGV applications, sufficient resolution of detection is achieved when an object (upright cylinder) with a diameter of 70 mm can be detected throughout the detection zone.



a = SIMATIC FS600 Laser Scanner
b = AGV
c = Height of the test piece, max. 200 mm
d = Recommended maximum height of the scanning plane: 150 mm
e = Axis of the rotating mirror
S = Safety distance
S_T = Depth of the detection zone
Z_{TOT} = Detection zone additions in the direction of travel

Fig. 5.7-1: Mounting height on an AGV

Depending on the application, further additions may be necessary. Additional information is available in Chapter 5.7.6.

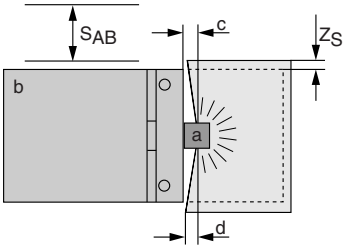
5.7.5 Recommendations for Mounting to Prevent Unmonitored Zones

The creation of unmonitored zones is dependent upon the following factors:

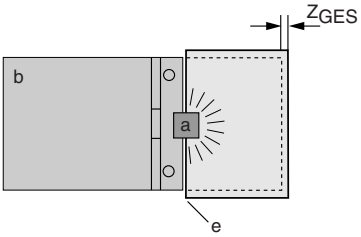
- the vehicle width
- the design of the vehicle (e.g. attachments, shape)
- the position of the scanner
- the installation depth
- the selected angle range.

If the detection zone of a SIMATIC FS600 Laser Scanner mounted on an AGV does not cover the entire front of the vehicle, you can prevent the creation of unmonitored zones by changing the installation depth of the scanner or by adjusting the angle range (from 180° to 190°).

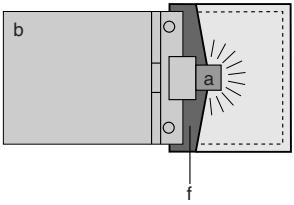
If this is not possible due to constructional limitations, additional safety measures such as mechanical cover panels, switch strips or bumpers must be implemented.
Please comply with the safety notes in Chapter 3.7.



SIMATIC FS600 Laser Scanner mounted on the front of a vehicle



SIMATIC FS600 Laser Scanner recessed into the front of a vehicle



SIMATIC FS600 Laser Scanner mounted on a protruding vehicle

a = SIMATIC FS600 Laser Scanner
b = Automatic guided vehicle
c = The distance from the back wall of the scanner to the axis of the rotating mirror is 68 mm.
d = The 190° detection zone enables an expanded monitored range.
e = The detection zone is limited by the scanner recess at the front of the vehicle (180°).
f = The protruding attachment results in the creation of unmonitored zones.
S_{AB} = Lateral safety distance (between the edge of the roadway and the boundary of the detection zone).
Z_{TOT} = Sum of the system- and application-specific additions in the direction of travel
Z_S = Sum of the system- and application-specific additions to the side

Fig. 5.7-2: Three possibilities for mounting the SIMATIC FS600 Laser Scanner onto an AGV

5.7.6 Additions

The axis of the rotating mirror (midpoint of the scanner) is of critical importance when configuring the detection zones. This axis is assigned a value of 64 mm from the front edge of the scanner when calculating detection zones.

Add **83 mm** or **100 mm** for the maximum radial measurement error Z_{SM} as described in Chapter 5.3.5 .

Add an addition Z_{REFL} as described in Chapter 5.3.5 if reflectors could be present in the area.

Without information from the AGV manufacturer, take into account the wear and tear on the brakes by adding an addition L_{STOP} of at least 10 % of the braking distance, as long as this is not already included in the braking distance S_{STOP}.

If there is a very small distance between the bottom of the AGV and the floor, the detection difference between the leg and the toes must be considered in the calculation. For AGVs with a floor clearance of less than 120 mm, an addition Z_{AFLR} must be added. This refers only to the travel of direction.

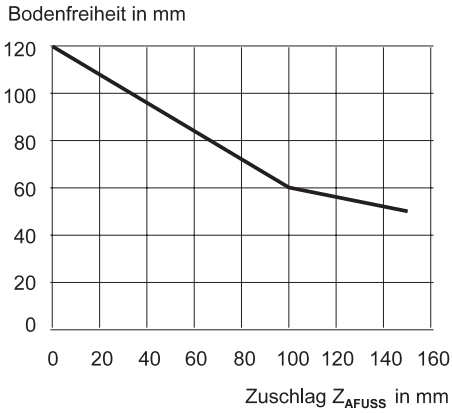


Fig. 5.7-3: Diagram for calculating the addition to compensate for inadequate AGV floor clearance

5.7.7 System Availability

There must be a buffer distance of 83 mm between the surrounding contour and the detection zone contour (including the additions). This distance increases the up-time of the AGV, since it prevents the surrounding contour from being detected as relevant for generating a switch-off signal due to a measurement error.

Furthermore, the dust algorithm of the SIMATIC FS600 Laser Scanner can be implemented if floating particles may be present in the area. This algorithm can be activated in the user program “SIMATIC FS600 Parameterization Software LS4soft” and prevents the AGV from being switched off unintentionally. Please note Chapter 5.3.5.

If the danger zone analysis allows a multiple evaluation, detection errors caused by floating particles can be decreased. The number of evaluations that is decisive for the response time of the scanner (T_{SCAN}), and thus also requires a larger detection zone, can be set in the user program “SIMATIC FS600 Parameterization Software LS4soft”.

In the event of an error event that lasts only briefly (for example the effect of extraneous light) the scanner performs a one-time reboot. If automatic startup and restart are activated, the scanner turns the OSSDs back on after this brief error event, and after the detection zone has been free for about 25 seconds. This one-time reboot results in an additional increase in availability. This function does not have any effect if detection zone activation is faulty. If startup test, startup interlock and / or manual restart are included, they will not be removed.

⚠ SAFETY NOTES
Automatic startup / restart must only be used in cases where there is absolutely no possibility that the effective detection zone could be entered or bypassed in some other way. Depending on the hazard assessment, visual and / or acoustic startup warnings should be provided.

If parameters are set for the function “Manual restart”, the required enable from the startup/restart button affects all detection zones and is independent of any detection zone changeover. If the current detection zone is manually enabled, this enable also applies even if the system switches to another detection zone and this detection zone becomes free! If startup/restart interlock is in effect in the current detection zone, it is also in effect for the other detection zone to which the system switches even if this detection zone is free.

5.7.8 Restart

At least 2 seconds must elapse following the release of a violated detection zone before the AGV is allowed to start up again (in accordance with DIN EN 1525). The restart can be initiated either manually or automatically. In case of automatic restart, the delay time of up to 10 s can be set in advance using the program “SIMATIC FS600 Parameterization Software LS4soft”. If a restart button is provided, it must be mounted outside the danger zone at a position from which the entire danger zone can be viewed. The areas that will be released must also be referred to in an easily understandable manner. The startup/restart interlock affects all detection zones and does not depend on any detection zone changeovers.
Please comply with the safety notes in Chapter 3 and Chapter 5.7.7.

5.7.9 Calculating the Dimensions of the Detection Zone of an AGV Application

Following are the specifications and calculation examples for the mobile safeguarding of automatic guided vehicles..

According to **IEC 61496-3**, the following formulas apply for calculating the safety distance:

$S = (V_{MAX} \times T) + S_{STOP}$

V_{MAXAGV}= Maximum speed of the AGV, in mm/s
T = Response time of the scanner and the AGV, in s
S_{STOP} = Braking distance of the AGV until standstill, in mm

5.7.9.1 Direction-Related Minimum Depth of the Detection Zone and Additions

The depth of the detection zone in the direction of travel, with respect to the distance between the edge of the roadway and the boundary of the detection zone, is calculated according to the following formula:

$$\mathbf{S_T = V_{MAXAGV} \times (T_{SCAN} + T_{FTS}) + (S_{STOP} \times L_{STOP}) + Z_{TOT}}$$

S_T = Depth of the detection zone in the direction of travel, in mm
V_{MAXAGV}= Maximum speed of the AGV, in mm/s
T_{SCAN} = Response time of the scanner, in s
T_{SCAN} = Response time of the AGV, in s
L_{STOP} = Factor for wear and tear on the brakes
Z_{TOT} = Total of the system- and application-specific additions in the direction of travel in mm

$$\mathbf{Z_{TOT} = Z_{SM} + Z_{REFL} + Z_{AFLR} + Z_{AU}}$$

Z_{SM} = Scanner measurement error, in mm
Z_{REFL} = Addition of the reflectors taken into account, in mm
Z_{AFLR} = Addition for inadequate floor clearance by the AGV, in mm
Z_{AU} = Application-specific addition, in mm

5.7.9.2 Maximum range of detection zone

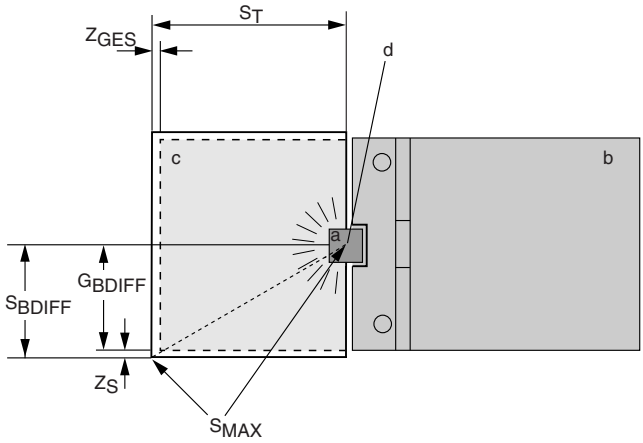
$$\mathbf{S_{MAX} = \sqrt{S_T^{\,2} + S_{BDIFF}^{\,2}}}$$

$$\mathbf{S_{BDIFF} = G_{BDIFF} + Z_S}$$

S_{MAX} = Maximum range of the detection zone, in mm
S_T = Depth of the detection zone in the direction of travel, in mm
S_{BDIFF} = Largest width of the detection zone, in mm
G_{BDIFF} = Largest width of the danger zone, in mm
Z_S = Sum of the system-specific and application-specific additions to the side, in mm

$$\mathbf{Z_S = Z_{SM} + Z_{REFL} + Z_{AU}}$$

Z_{SM} = Scanner measurement error, in mm
Z_{REFL} = Addition of the reflectors taken into account, in mm (see Chapter 5.3.5)
Z_{AU} = Application-specific addition, in mm



a = SIMATIC FS600 Laser Scanner
b = AGV
c = Detection zone
d = Axis of the rotating mirror
G_{BDIFF} = Largest width of the hazardous zone
S_{BDIFF} = Largest width of the detection zone
S_{MAX} = Geometrical maximum distances
S_T = Depth of the detection zone
Z_{GES} = Total of the additions in the direction of travel
Z_S = Total of the additions to the side

Fig. 5.7-4: Considering the maximum measurement distance for safeguarding AGVs

In accordance with DIN EN 1525, a minimum safety distance of 0.5 m width between the vehicle and its environment must be maintained.

5.7.9.3 Sample calculation of the depth of a detection zone

This example is based on the following typical application data (without access against the direction of travel and without retro-reflectors):

Largest width of the danger zone from the axis of the rotating mirror	= G_{BDIFF}	1400 mm
Maximum speed	= V_{MAXAGV}	1800 mm/s
Response time SIMATIC FS600 Laser Scanner (selectable)	= T_{SCAN}	0.08 s
Response time of AGV control	= T_{AGV}	0.1 s
Braking distance	= S_{STOP}	1900 mm
Factor for wear and tear on the brakes	= L_{STOP}	1.1 (fixed addition to account for wear and tear on the brakes)
Measurement error	= Z_{SM}	83 mm
Distance between AGV and floor	= Z_{AFLR}	90 mm (results in an addition of 50 mm according to Fig. 18 5.7-3 for calculating the addition for inadequate floor clearance)

The formula

$S = V_{MAXAGV} \times (T_{SCAN} + T_{FTS}) + (S_{STOP} \times L_{STOP})$

results in a safety distance of:

$S = 1800\ mm/s * (0.08\ s + 0.1\ s) + (1900\ mm * 1.1) = 2414\ mm$

$= 2414\ mm$

The formula

$S_T = S + Z_{SM} + Z_{REFL} + Z_{AFLR} + Z_{AU}$

results in the following required depth of the detection zone in the direction of travel:

$S_T = 2414\ mm + 83\ mm + 0\ mm + 50\ mm + 0\ mm = 2547\ mm$

5.7.9.4 Sample calculation of a maximum range of a detection zone

The formula

$$S_{MAX} = \sqrt{S_T^2 + S_{BDIFF}^2}$$

$$S_{BDIFF} = G_{BDIFF} + Z_S$$

yields, under consideration of the width of the danger zone results in the maximum distance to be monitored:

$$S_{MAX} = \sqrt{2547mm^2 + 1483mm^2}$$

$S_{BDIFF} = 1400\ mm + 83\ mm = 1483\ mm$

$S_{MAX} = 2947\ mm$

5.7.10 Side guarding configuration on AGVs

All previous considerations and the Chapter 5.7.9 calculation for calculating the detection zone measurements of an AGV application also apply for side guarding on AGVs. With AGVs that drive along conveyor segments it should always be ensured that big enough undercut is provided (see also, details in Chapter 5.4.4). If the structure of the conveyor segment does not allow an undercut, then it must be assumed that a person is in the space between the vehicle and the conveyor. This is especially the case with spaces of more than 100 mm. This person in the space between vehicle and conveyor should be detected simultaneously with a person in the driveway, which must be taken into consideration with the dimensioning of the detection and warning zones. The same safety distance calculations therefore apply.

A laser scanner resolution of 150 mm is required to detect an entire person. This safety-relevant setting is automatically set in the SIMATIC FS600 Parameterization Software LS4soft configuration and diagnostics software with selection of the "person detection" presetting. The definition of a reference contour as with access guarding is not necessary, as the approach of the person to be protected is made in the direction of the detection zone! If the conveyor segment height is over 500 mm and the distance between vehicle and conveyor is more than 100 mm, then the detection zone between vehicle and conveyor can be aligned. With conveyor segment heights below 500 mm there is the increased danger of the conveyor segment being crossed over. In this case the alignment of the detection zone with the conveyor edge guarantees detection of a person at this point. If a laser scanner resolution finer than 150 mm is additionally required for the safe position detection of the load, then this can also be selected in this application. The person in the in between space continues to be safely detected.

6 Details on switching over detection and warning zones

During the course of an optimum machine utilization an alternate infeed or machining cycle often occurs, which brings the most diverse danger areas with it. Automated guided vehicle system applications by their very nature include various danger areas, depending on the operating status. If the approach or presence of people is now to be expected in these areas, the need exists of a precisely adjusting safety system. With its four or eight switchable and freely configurable detection and warning zones (zone pairs), the SIMATIC FS600 Laser Scanner satisfies multifaceted requirements with regard to guarding the most diverse applications.

The definition of the necessary zone pair contours is possible with the convenient and easy to use configuration and diagnostics software, "SIMATIC FS600 Parameterization Software LS4soft".

The zone pairs are activated via the connection of 24 V DC to the corresponding control inputs, FP1 to FP4, which are provided on the X1 plug of the scanner, Please find detailed information on the scanner connection in Chapter 7.2 and Chapter 9.

If the SIMATIC FS600 Laser Scanner is to be restarted or switching is to be made between different zone pairs, the following points must be observed:

- The zone pair planned for the start must be defined with special consideration of the danger areas valid for this moment.
- The sequence of the monitoring zones to be activated must ensure that the lower threshold of the application-related detection zone minimum values is never crossed.
- With selection of zone pair 8 the monitoring function of the scanner is deactivated, i.e. no detection zones are monitored and the safety outputs (OSSDs) remain constantly active! With detection zone 8 the laser scanner may not be started. Detection zone 8 is planned for application-related situations in which it has been absolutely ensured that there is no danger for any people present. These are, for example, vehicles with crawler mode or in completely partitioned off and secured areas, vehicles in approach mode in the area of loading or parking positions, as well as machines in the "setup" operating mode.

Please observe the connection and interface assignment in Chapter 9.5 and the safety notes in Chapter 3.

6.1 Sequence of zone pair switchovers

The SIMATIC FS600 Laser Scanner has four or eight detection/warning zones. Switchover between these zone pairs is possible at all times, provided the operating situation allows this. During the switchover process the SIMATIC FS600 Laser Scanner monitors the zone pair activated before the switchover until a new one has been clearly activated. The rules for the switchover depend on the amount of the selected zone pairs and their numbers. The procedures described in the following tables apply.

Table 6.1-1 applies with activation (start or switchover) of zone pairs 1 to 4.

Zone pair	Control input FP1-FP2-FP3-FP4	
1	1 - 0 - 0 - 0	Zone pair 1 is active
2	0 - 1 - 0 - 0	Zone pair 2 is active
3	0 - 0 - 1 - 0	Zone pair 3 is active
4	0 - 0 - 0 - 1	Zone pair 4 is active

Table 6.1-1: Connection of control inputs FP1 to FP4 with activation of zone pairs 1 to 4

The following points also apply for the switchover:

- The second zone pair must always be switched off first, then the first zone pair.
- The switchover must be made within 1 sec. Both zone pairs are monitored during the switchover time.
- The switching process may not include the deactivation of all zone pairs at any time.
- The switchover process executed by the control unit must concur with the laser scanner's configuration, which was set beforehand with SIMATIC FS600 Parameterization Software LS4soft.

If these points are not observed the laser scanner will fail within 40 ms and will show this with the additional 2 Hz flashing of the green LED 1.

Table 6.1-2 applies with activation (start or switchover) of zone pairs 1 to 8.

Zone pair	Control input FP1-FP2-FP3-FP4	
1	1 - 0 - 0 - 0	Zone pair 1 is active
2	0 - 1 - 0 - 0	Zone pair 2 is active
3	0 - 0 - 1 - 0	Zone pair 3 is active
4	0 - 0 - 0 - 1	Zone pair 4 is active
5	1 - 1 - 1 - 0	Zone pair 5 is active
6	1 - 1 - 0 - 1	Zone pair 6 is active
7	1 - 0 - 1 - 1	Zone pair 7 is active
8	0 - 1 - 1 - 1	Zone pair 8 is active

Table 6.1-2: Connection of control inputs FP1 to FP4 with activation of zone pairs 1 to 8

The following points also apply for the switchover:

- The switchover must be made within 40 ms, i.e. after 40 ms one of the input connections shown in Table 6.1-2 must be valid and provided stable. During the switchover time the old zone pair is monitored; the new one after max. 80 ms.
- The switchover process executed by the control unit must concur with the laser scanner's configuration, which was set beforehand with SIMATIC FS600 Parameterization Software LS4soft.

If these points are not observed the laser scanner will fail within 40 ms and will show this with the additional 2 Hz flashing of the green LED 1.

6.2 Practical AGV Application (Example)

The following example shows the sequence of zone pair changeovers for an efficiently implemented AGV under consideration of the ambient conditions. Please observe the particular danger zone analysis for each detection zone in combination with the corresponding route segments. Also note the safe sequences of changeovers and starts. For information on programming the startup detection zones (detection zones enabled for starting up the scanner) and on determining the sequence in which the detection zones are to be activated, please see the "SIMATIC FS600 Parameterization Software LS4soft" user's manual.

Activating an FP	AGV position	Deactivating an FP	AGV control of position
FP1	Straight section		High speed
FP2	2 m before the curve	FP1	Low speed
FP3	Beginning of the curve	FP2	Steering lock - curve
FP1	Straight section	FP3	Steering lock - straight High speed

FP = 1 x detection zone + 1 x warning zone
Table 6.2-1: Practical AGV Application

If the AGV is controlled by a PLC, for instance, which corresponds to Cat. 3 or higher according to DIN EN 954-1, the previous zone pair (FP) can be deactivated immediately after the next zone pair has been activated, with no time delay.
This results in a faster switching sequence.

The applicable safety guidelines and standards as well as the operating instructions for the systems must be strictly complied with.

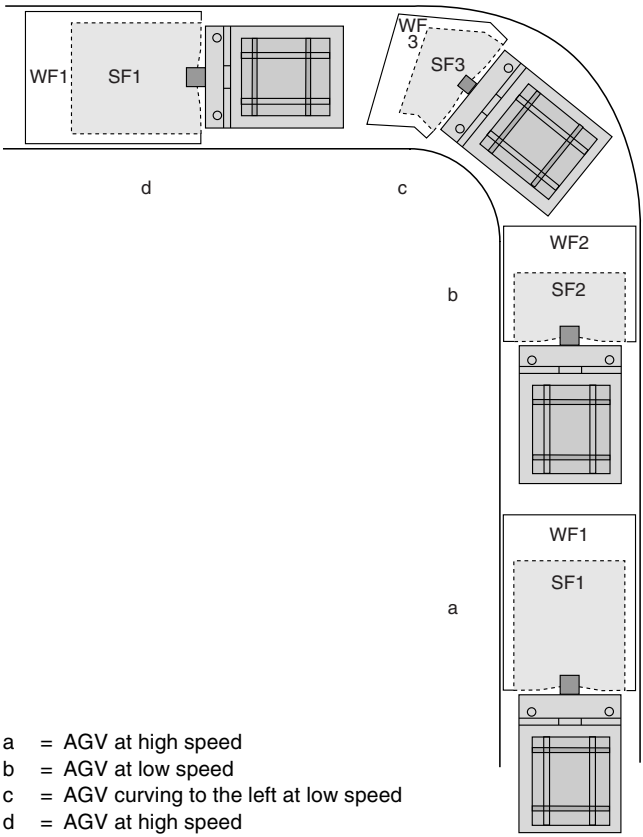


Fig. 6.2-1: Example of a zone pair changeover for an AGV on a curved route

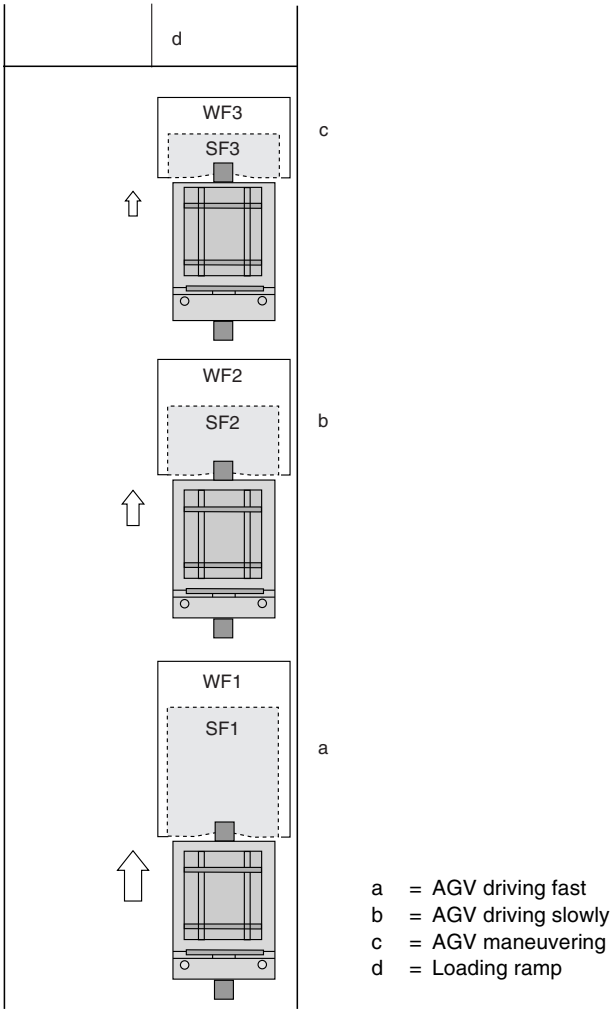


Fig. 6.2-2: Example of zone pair changeover with combined with reducing speed of the AGV

7 Functions of the SIMATIC FS600 Laser Scanner

The SIMATIC FS600 Laser Scanner is equipped with the X1 and X2 interfaces. The following functions are available through them:

7.1 Restart

Depending on the operating state, the restart input X1-2 has several functions:

- Enables the restart interlock following the interruption of a detection zone
- Enables the start interlock following a system start
- Restarts after a device error has been eliminated
- Recognizes a defined enable signal
  - after a device error
  - after a detection zone interruption for enabling the restart interlock

To activate the functions, apply 24 V to input X1-2. In the meantime, the safety outputs OSSD 1 and OSSD 2 are switched off; the indicator at the scanner (LED3) is lit up red. The duration of the signal must be between 0.12 s and 5 s.

The restart input X1-2 must be connected to an external, permanently installed button. X1-2 must not be connected with the remaining controls in order to prevent an unintended release with a Restart pulse under some circumstances.

Force-guided, normally closed contacts can be monitored in the restart circuit (relay monitoring).

Please note the Chapter 5 (planning and mounting information) and 9.1 (electrical power supply).

7.2 Channels for Zone Pair Changeovers, FP 1 to FP 4

To activate the zone pairs, apply +24 V (see Chapter 9.1) to the following inputs:

- X1-4 (FP1)
- X1-6 (FP2)
- X1-7 (FP3)
- X1-8 (FP4)

When changing over the zone pairs, please note that the new zone pair must be switched on before the previous pair is switched off. The procedures is allowed to last a maximum of 1 s. If this time period is exceeded, or if the previous zone pair is switched off too soon, the SIMATIC FS600 Laser Scanner reports an error by switching off the two OSSDs and the alarm output. In addition, this state is shown in the indicator field on the scanner; flashing of left LED1 (slowly at 2 Hz), LED3 and right LED5 (fast at 4 Hz).

7.3 Alarm 1 (X1-5)

As long as the output X1-5 is switched on, the system signals trouble-free operation. If it is switched off, the following states are reported:

- Interruption of the warning zone is shown by the continuously lit LED 2 in the indicator field of the scanner.
- Warning state:
  For instance, the system may detect a slight dirt buildup on the optical window. To signal this state, LED 5 on the scanner flashes (2 Hz). The user should clean the optical window before it gets dirtier; waiting too long will cause a device error to be reported and the outputs OSSD 1 and OSSD 2 to be switched off.
- Device error:
  Such as an erroneous reference measurement or extreme dirt buildup on the optical window. This state is signaled by LED 5 flashing quickly (4 Hz).

Both the reporting of a warning zone interruption and the signaling of the warning and error state can be selected either separately or in combination. This procedure is described in the user's manual for the program “SIMATIC FS600 Parameterization Software LS4soft”.

Output X1-5 is equipped with an internal electronic current limit to protect it against damage from overload.

7.4 Alarm 2 (X1-15)

As long as the output X1-15 is switched on, the system signals trouble-free operation. If it is switched off, the following states are reported:

- Warning state:
  For instance, the system may detect a slight dirt buildup on the optical window. To signal this state, LED 5 on the scanner flashes (2 Hz). The user should clean the optical window before it gets dirtier; waiting too long will cause a device error to be reported and the outputs OSSD 1 and OSSD 2 to be switched off.
- Device error:
  Such as an erroneous reference measurement or extreme dirt buildup on the optical window. This state is signaled by LED 5 flashing quickly (4 Hz).

Output X1-15 is equipped with an internal electronic current limit to protect it against damage from overload.

7.5 OSSD 1 (X1-12) and OSSD 2 (X1-11)

When the detection zone is interrupted, the two semiconductor outputs switch off and, by way of elements such as positively guided relays, cause the monitored machine(s) to shut down.

It is not admissible to control different safety circuits with a single OSSD. Connected loads must exhibit a low-pass behavior in accordance with the plausibility control conducted by the scanner ($f_g \leq 1$ kHz, $C_L \leq 100$ nF). The OSSDs are equipped with an internal electronic current limit to protect them against damage from overload.

For some sample connections, see Chapter 8.

7.6 Data Communication

The interface X2 allows the SIMATIC FS600 Laser Scanner to support two types of connections to the PC or laptop.

Communication via the X2 connector in RS232 mode does not require any further bridging. To enable data transfer in RS 422 mode, connect pin 5 with pin 6. The scanner automatically adjusts itself to the appropriate transfer type and baud rate.

The interface (X2) is used for

- configuring and setting parameters for the SIMATIC FS600 Laser Scanner
- transferring measurement data while the scanner is in operation
- evaluating the coordinates during parameter setting (e.g. for AGV applications)
- advanced status and control diagnostics.

Guard operation is only permitted with the PC cable (X2) or dummy connected screwed on. This also applies for transport and storage.

Please note the pin assignments specified in Chapter 9.5 . For additional information on using the X2 interface, refer to the user's manual for the program “SIMATIC FS600 Parameterization Software LS4soft”.

8 Integrating the SIMATIC FS600 Laser Scanner into Machine Controls

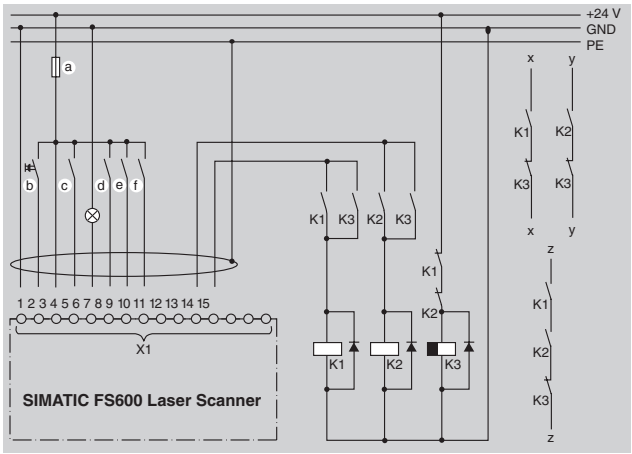
The following examples illustrate possibilities for integrating the SIMATIC FS600 Laser Scanner into machine controls.

Once the operating voltage pin X1-3 (+UB) has been connected to pin X1-1 (GND) and a detection zone has been activated (X1-4, X1-6, X1-7 or X1-8), the unit is ready for operation.

Please see the point “Start detection zone” in the user's manual for the program “SIMATIC FS600 Parameterization Software LS4soft”.

8.1 Integrating the SIMATIC FS600 Laser Scanner with External Wiring with Relays and Quadruple Zone Pair Changeover

In this connection example, the restart interlock function is provided by the connected command unit “WA”, which applies the voltage of 24 V to the input RESTART X1-2. The SIMATIC FS600 Laser Scanner itself must be configured using the “SIMATIC FS600 Parameterization Software LS4soft” user software so that the operating mode “with restart interlock” is active.



a	=	Fuse 1.25 A, semi time-lag	d	=	DZ 2/WF 2
b	=	Restart button	e	=	DZ 3/WF 3
c	=	DZ 1/WF 1	f	=	DZ 4/WF 4

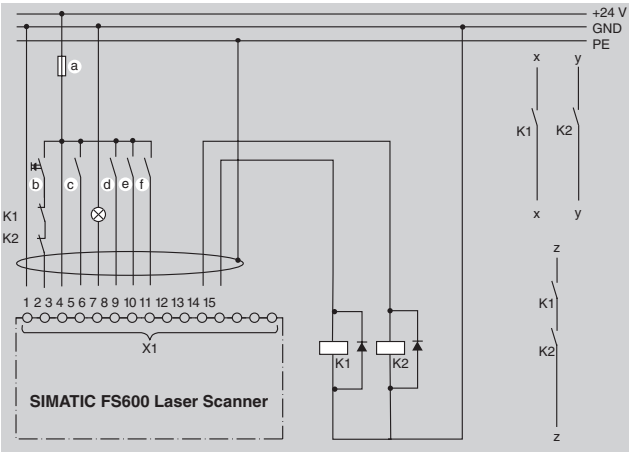
Fig. 8.1-1: Wiring the SIMATIC FS600 Laser Scanner with evaluation of the OSSDs, zone pair changeover and restart interlock (example)

Relays K1 and K2 must have forced contacts. They are operated directly at the two failsafe semiconductor outputs OSSD 1 (X1-12) and OSSD 2 (X1-11).

Relay K3 has a deenergizing delay. A suitable mechanism must be provided for extinguishing sparks. Please note that doing this will cause the switching time to be extended.

Channels “x” and “y” must be integrated for Category 3 in accordance with DIN EN 954-1. Integrating one channel based on “z” is only permitted with a one-channel control system and taking into consideration the results of a risk analysis.

Serial machine controls are admissible only insofar the valid regulations allow.



a	=	Fuse 1.25 A, semi time-lag	d	=	DZ 2/WF 2
b	=	Restart button	e	=	DZ 3/WF 3
c	=	DZ 1/WF 1	f	=	DZ 4/WF 4

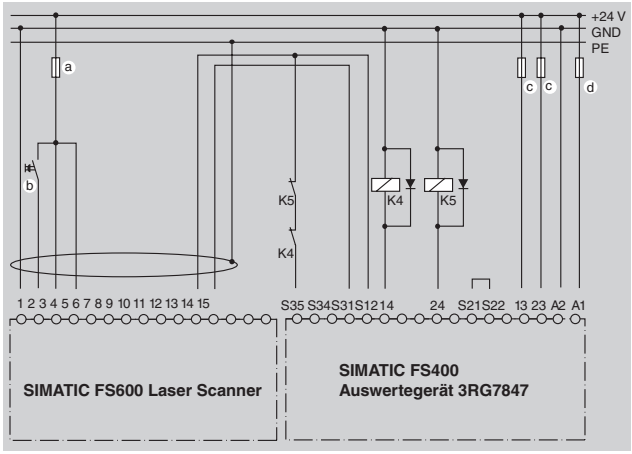
Fig. 8.1-2: Wiring the SIMATIC FS600 Laser Scanner with evaluation of the OSSDs, zone pair changeover, restart interlock and static relay monitoring

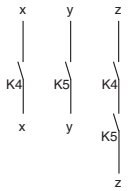
Relays K1 and K2 must have forced contacts. They are operated directly at the two failsafe semiconductor outputs OSSD 1 (X1-12) and OSSD 2 (X1-11).
A suitable mechanism must be provided for extinguishing sparks. Please note that doing this will cause the switching time to be extended.

Channels “x” and “y” must be integrated for Category 3 in accordance with DIN EN 954-1. Integrating one channel based on “z” is only permitted with a one-channel control system and taking into consideration the results of a risk analysis.

Serial machine controls are admissible only insofar the valid regulations allow.

8.2 Connecting the SIMATIC FS600 Laser Scanner to a Safety Sequence Circuit with Manual Restart, Relay Monitoring, without Zone Pair Changeover





a = Fuse 1.25 A, semi time-lag
b = Restart button
c = Fuse 4 A, delay-action
d = Fuse 1 A, delay-action

Fig. 8.2-1: Wiring the SIMATIC FS600 Laser Scanner with external restart interlock and relay monitoring, and without zone pair changeover

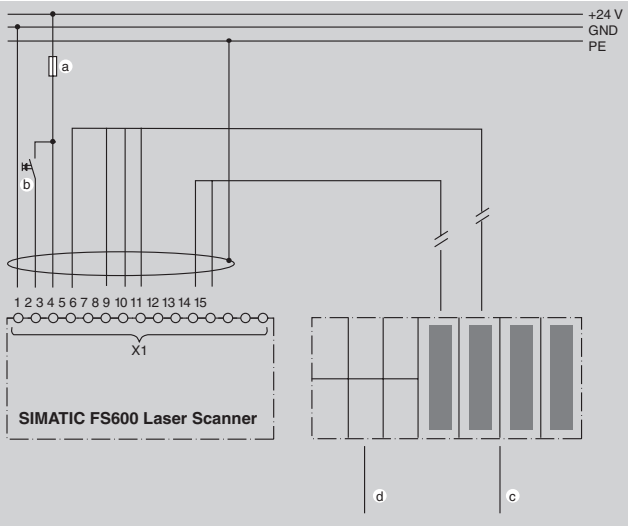
In this example, the relay monitoring is performed by an external safety module (e.g. MSI-SR2/F). Relays K4 and K5 must be equipped with positively guided contacts. A suitable mechanism must be provided for extinguishing sparks. Please note that doing this will cause the switching time to be extended.

Please refer to the operating instructions for the components.

Channels “x” and “y” must be integrated for Category 3 in accordance with DIN EN 954-1. Integrating one channel based on “z” is only permitted with a one-channel control system and taking into consideration the results of a risk analysis.

Serial machine controls are admissible only insofar the valid regulations allow.

8.3 Connecting the SIMATIC FS600 Laser Scanner to a PLC with Corresponding Safety Level (Cat. 3 or higher, EN 954) and Zone Pair Changeover



a = Fuse 1.25 A
b = Restart button
c = Peripherals, e.g. ET200M with failsafe signal subassembly
d = Further processing by a failsafe PLC, e.g. SIMATIC S7-300F

Fig. 8.3-1: Connecting the SIMATIC FS600 Laser Scanner to a failsafe PLC with a safety level (at least Cat. 3, EN 954) and zone pair changeover (example)

All switching functions in this sample connection are controlled directly by the PLC.

The changeover of 4 zone pairs is achieved by way of the inputs X1-4 (FP1), X1-6 (FP2), X1-7 (FP3) and X1-8 (FP4).

For applications in which the scanner must be separately enabled for its detection zone, the signal can be given either by the machine controls or by connecting a command unit for restart interlock. The SIMATIC FS600 Laser Scanner itself must be configured using the “SIMATIC FS600 Parameterization Software LS4soft” user program so that the operating mode “with restart interlock” is active.

9 Electrical connection

9.1 Electrical Power Supply

The SIMATIC FS600 Laser Scanner requires a direct voltage of 24 V and 8 W of power plus the load at the outputs (max. 25 W).

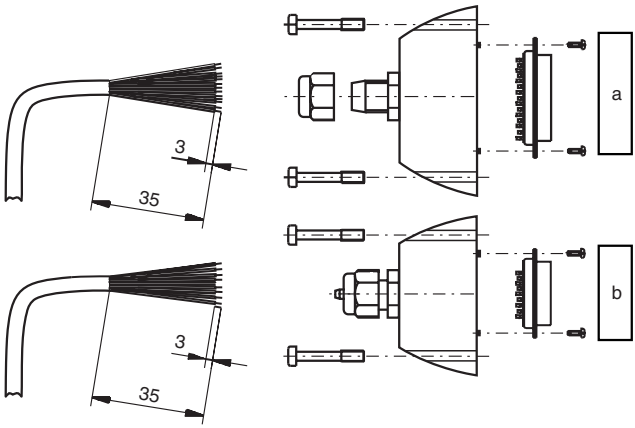
The power must be supplied by way of an external 1.25 A, semi time-lag fuse (e.g. in an electronics cabinet). In addition, a permanent current of 2.5 A must be ensured before safeguarding begins in order to guarantee that the fuse will be triggered in case of a fault.

In keeping with electrical safety requirements, the power to the SIMATIC FS600 Laser Scanner all connected input and output circuits must be provided by a power supply unit with protective isolation from a safety transformer according to IEC 742 or comparable (this also applies for the use of battery chargers for AGV applications).

9.2 Connecting the PC and Control Cables to the Scanner

Three connector adapters with cable screw coupling are supplied with the SIMATIC FS600 Laser Scanner. Two of these are needed to accommodate the 9-pin Sub-D connector and the 15-pin Sub-D jack (PC cable and control cable). Two of these are needed to accommodate the 9-pin Sub-D connector and the 15-pin Sub-D jack (PC cable and control cable). A housing is used as protection of the X2 interface if data communication with the PC is desired.

The cable screw couplings can accommodate cable diameters from 6.5 mm to 10.5 mm.



a = Jack X1
b = Connector X2

Fig. 9.2-1: Preparing the connectors

The connector adapter of control cable X1 must be connected with interface X1 and screwed tightly to the SIMATIC FS600 Laser Scanner. The connector adapter of cable X2, or else the X2 dummy cap (without a cable), must also be screwed tightly to the SIMATIC FS600 Laser Scanner. Threaded drill holes are located on the top of the scanner housing for this purpose. If one of the two connection housings is missing, the SIMATIC FS600 Laser Scanner no longer meets the requirements of protection type 65. For information on the assignment of the connector, please refer to Chapter 2.2 and 9.5 the connection and operating instructions of the SIMATIC FS600 Laser Scanner.

9.3 Connector Assembly

Every connector adapter consists of the following individual parts:

- Housing with sealing ring and fastening bolts
- Cable screw coupling (M16) with dummy plugs
- Sub-D9 connector and/or Sub-D15 connector, each with a solder connection

9.4 Points to Consider When Preparing and Laying the Cables

- The cross-section of cable X1 must be at least 0.5 mm^2.
- The outer diameter of the cable must be between 6.5 mm and 10 mm.
- The maximum cable length for X1 is 50 m.
- The maximum cable length for X2 is 10 m (for RS232).
- The maximum cable length for X2 is 50 m (for RS422, twisted pair).
- Use shielded cables.
- Connect the cable shielding with PE to the electronics cabinet only.
- The cables must not be laid loose.

Scanner control cables may not be laid in a stand parallel to power supply cables for machines. This minimizes the effects of inductive interference factors from motors carrying high current. In addition, the cables should be laid so that they cannot be damaged (e.g. by being crushed or pinched).

Cabling prepared for connection to the scanner is available as an optional accessory in various lengths and for both interfaces. For further information, see Chapter 13.

9.5 Interface Pin Assignments

Pin Assignments for Connector X1

PIN	Signal	Description
1	GND	Power supply ground
2	Restart	Input, scanner reset, and connecting the restart button of the restart button
3	UB	+24-V DC power supply; protected by a 1.25 A delayed-action fuse
4	FP 1	Zone pair control input
5	Alarm 1	Semiconductor output that switches off when the warning zone is violated as well as for warning messages such as “optical window slightly dirty”, error messages such as “optical window very dirty”, and for internal errors (the functions can also be selected in combination).
6	FP 2	Zone pair control input
7	FP 3	Zone pair control input
8	FP 4	Zone pair control input
9	NC	Reserved
10	NC	Reserved
11	OSSD 1	Semiconductor output, switches off when the detection zone is violated, Channel 1
12	OSSD 2	Semiconductor output, switches off when the detection zone is violated, Channel 2
13	NC	Reserved
14	NC	Reserved
15	Alarm 2	Semiconductor output with shut-off when warning and malfunction message

Table 9.5-1: Pin Assignments for Connector X1

Pin Assignments for Connector X2 used as an RS 232 Port

PIN	Signal	Description
1	- - -	Reserved
2	TxD	Data communication, transmit
3	RxD	Data communication, receive
4	- - -	Reserved
5	GND/shield	Ground / shield
6	RS 232	Reserved
7	NC	Do not assign
8	NC	Do not assign
9	Reserved	Reserved for testing purposes

Table 9.5-2: Pin Assignments for Connector X2 used as an RS 232 Port

Pin Assignments for Connector X2 used as an RS 422 Port

PIN	Signal	Description
1	Tx +	Data communication, receive
2	Tx -	Data communication, receive
3	Rx -	Data communication, transmit
4	Rx +	Data communication, transmit
5	GND/shield	Ground / shield
6	RS 422	Select RS422 interface by connecting a bridge to pin 5
7	NC	Do not assign
8	NC	Do not assign
9	Reserved	Reserved for testing purposes

Table 9.5-3: Pin Assignments for Connector X2 used as an RS 422 Port

For the pin arrangement, please refer to Chapter 2.2 and 9.5 the connection and operating instructions of the SIMATIC FS600 Laser Scanner.

10 Commissioning

Communication with the PC or laptop needs to be established so that the SIMATIC FS600 Laser Scanner can be configured and the detection zones and warning zones can be programmed.
This is also necessary for displaying the measurement contours and for the system check.

The program “SIMATIC FS600 Parameterization Software LS4soft”, which is included with delivery, makes this easy and convenient to do. Refer to the operating instructions to find additional important information and helpful explanations.

10.1 Hardware and Software Requirements

The following components are required for the initial startup:

- SIMATIC FS600 Laser Scanner
- RS232 interface cable (1:1, without cross-connection)
- Shielded control cable for the power supply and for activating a zone pair
- Power supply that meets the requirements specified in Chapter 9.1
- PC or laptop, color monitor
- “SIMATIC FS600 Parameterization Software LS4soft” program

The PC should fulfill the following requirements:

- Intel® processor, Pentium® class or higher (or compatible models such as AMD® or Cyrix®)
- At least 64 MB RAM
- CD drive
- Hard drive with at least 50 MB of free memory (more if detection zone data and/or configuration data are going to be stored)
- Mouse
- Interface RS 232 (serial)
- Microsoft® Windows 95/98/NT®/2000/XP®

10.2 Installing “SIMATIC FS600 Parameterization Software LS4soft” and Starting Up the SIMATIC FS600 Laser Scanner

- First, run the installation program “start.exe” in order to install the program on the PC.
- Start the software by calling up the program.
- Connect the control cable and the PC cable.
- Then apply the supply voltage to the SIMATIC FS600 Laser Scanner. The scanner will now attempt to communicate with the PC; this process is displayed on the screen.

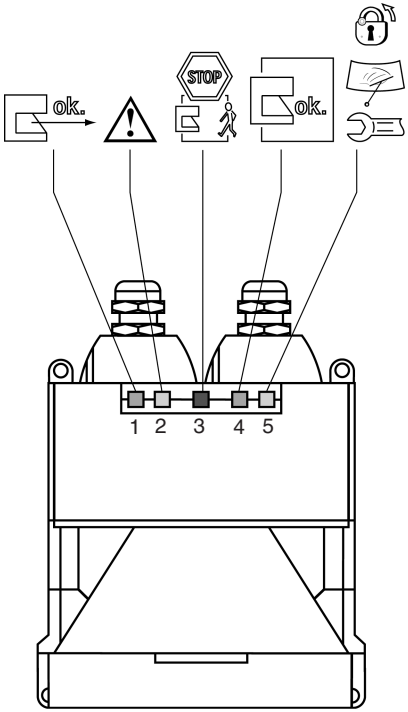
- If the connection between the SIMATIC FS600 Laser Scanner and the PC was successful, you can enter the appropriate password and then change the parameters and zone pairs of the SIMATIC FS600 Laser Scanner to meet the needs of the particular application.
  The standard password to be entered in the authorized level "Authorized Customer" of the SIMATIC FS600 Laser Scanner is: "LS4SIG". Please note that the password must be changed following the initial configuration of the scanner, and that the data carrier must be kept locked up in a secure location.
- The SIMATIC FS600 Laser Scanner is ready for operation once the scanner settings and detection zone configurations have been transferred.

Every SIMATIC FS600 Laser Scanner is factory-equipped with the maximum safety parameters. For this reason, first the device settings and then the detection zones must be adapted to the requirements of the application before the scanner is put into operation. After configuring the scanner, remove the PC interface cable from position X2, slip on the dummy cap provided with delivery, and screw it tight.

For a list of parameters, please see the in the Configuration and Diagnostics Software "SIMATIC FS600 Parameterization Software LS4soft".
Please observe Chapter 11, Testing and Maintenance.

10.3 SIMATIC FS600 Laser Scanner status indicator

There are five LEDs located on the front of the scanner behind the cover with the matte finish. These LEDs indicate the status of the SIMATIC FS600 Laser Scanner.



Association to function:

Easy-to-interpret pictographs on SIMATIC FS600 Laser Scanner provide information on the meaning of the LEDs

1 = Green
2 = Yellow
3 = Red
4 = Green
5 = Yellow

Fig. 10.3-1: The SIMATIC FS600 Laser Scanner status indicator

Meaning of the individual LEDs

LED	Color	Function / Meaning	Pictograph
1	Green	• Sensor function is active, active detection zone is free • Fault input zone pairs, Light flashing at 2 Hz	
2	Yellow	• Warning zone is assigned • Configuration conflict, Light flashing at 4 Hz	
3	Red	OSSD outputs are switched off	
4	Green	OSSD outputs are switched on	
5	Yellow	• Constantly lit: Start interlock Restart interlock • Flashing slowly (1): Warning message (approx. 2 Hz) Optical window dirty • flashing quickly (((1))): device message (approx. 4 Hz)	

Table 10.3-1: Meaning of the SIMATIC FS600 Laser Scanner LED displays

10.4 Status information of the SIMATIC FS600 Laser Scanner

Scanner display LED numbers 1 2 3 4 5	Indicator	Status
– – 1 0 –	LED 3	The OSSD outputs are switched off (e.g. during booting).
1 0 0 1 0	LED 1 LED 4	The sensor function is active (measurement operation without an interruption of the activated zone pair). The OSSDs are switched “active high”.
1 1 0 1 0	LED 1 LED 2 LED 4	The sensor function is active (measurement operation without a violation of the activated detection zone). Violation of the activated warning zone. The OSSDs are switched “active high”.
0 1 1 0 –	LED 2 LED 3	Violation of the warning zone. Violation of the detection zone. The OSSDs are switched off.
1 0 0 1 (1)	LED 1 LED 4 LED 5	The sensor function is active (measurement operation without a violation of the activated detection zone). The OSSDs are switched “active high”. Warning message signaled by slow flashing at approx. 2 Hz (e.g. with optical window dirty)
0 0 1 0 (((1)))	LED 3 LED 5	The OSSDs are switched off. Fault message indicated by fast flashing at about 4 Hz (e.g. with defect or safety-related fault)
1 0 1 0 1	LED 1 LED 3 LED 5	The sensor function is active (measurement operation without an interruption of the activated zone pair). The OSSDs are switched off. Restart interlock is active.
0 1 1 0 1	LED 3 LED 5	Interruption of the zone pair. The OSSDs are switched off. Restart interlock is active.

1 = LED is lit up
0 = LED is dark
– = undefined

Table 10.4-1: Status information of the SIMATIC FS600 Laser Scanner

Upon delivery, the SIMATIC FS600 Laser Scanner is programmed with the largest possible detection zone and with activated startup interlock and manual restart. For this reason, LED 5 is constantly lit up when the scanner is switched on. When starting up your SIMATIC FS600 Laser Scanner, please modify the parameters to meet the specific needs of your application.

10.5 Restart and device swap-out

The SIMATIC FS600 Laser Scanner can be connected via the X1 standard plug or the ConfigPlug with integrated configuration memory. With a restart the laser scanner starts in every case with the configuration that was set when it went out of operation. Thereafter a technical expert does not have to look at it, but the test in accordance with the specifications for daily testing must be performed.

With a device swap-out, however, the procedure is different!

⚠ WARNING
If the X1 standard plug is used the configuration must be transferred with the PC to the replacement device. All procedures and specifcations of the first start-up apply here. A technical expert should look at the device!

If the ConfigPlug is used with integrated configuration memory, the SIMATIC FS600 Laser Scanner reads the saved configuration automatically from the ConfigPlug when it is switched on. The ConfigPlug must be clearly identified with a nameplate and the switch in the plug must be at the "1" (left) defalt position. During the start up with the automatic configuration read-back, the laser scanner signals the successful transfer with a brief flashing of the two yellow LEDs 2 and 5. In this case it does not have to be looked at by a technical expert, but the test in accordance with the specifications for daily testing must also be performed.

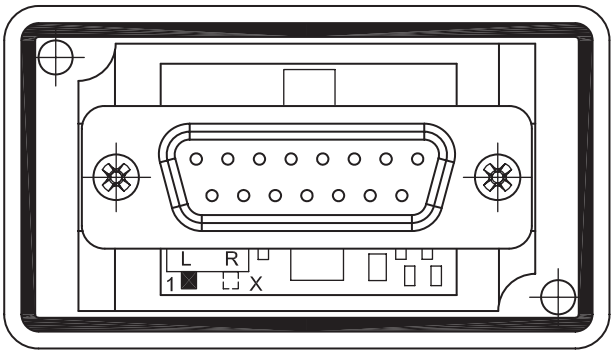


Fig. 10.5-1: SIMATIC FS600 Laser Scanner ConfigPlug with switch setting "1"

11 Maintenance and Testing

When placing the system in service for the first time, when it has been out of service for some time, after conversions and repair work, make certain the scanner and any other safety parts are checked specifically for the application and operation by the responsible trained specialist. This must be done taking into consideration applicable local requirements, especially for guidelines on machines and using work material and work safety guidelines. If the correct functionality is not clearly confirmed or if safety-related parameters have been changed, turn the machine or vehicle off immediately. Stopgap measures are not permitted.
Please comply with the safety notes in Chapter 3!

11.1 Test before First Startup by Person Qualified and Authorized to Perform the Task

- Check in accordance with the guidelines cited above, using the checklists provided below if necessary to verify that the protective equipment has been properly attached is connected to the control system electrically and that its effect works in all operating modes of the machine or vehicle.
- The result of the test must be documented, along with the scanner setting, in an understandable form. Printouts of scanner parameters and all defined detection zone contours must be included with the materials. Keep these where they are inaccessible for unauthorized personnel.
- During initial startup, you should anticipate unexpected behavior in the machine or vehicle. Because of this, people must be kept out of the danger area.
- Operating personnel must be instructed by trained specialists before starting work. Instruction is part of the area of responsibility of the machine operator.
- Ensure that a daily test is performed. Please take note in this regard of the “Daily Test with the Test Piece Performed by Responsible Operating Personnel”.

11.2 Extended Shutdown of the SIMATIC FS600 Laser Scanner

If a system is taken out of operation and the SIMATIC FS600 Laser Scanner is placed in storage for later use with other machines/vehicles, the factory settings should be restored. Please see the chapter entitled “Setting Detault Values in the Scanner” in the SIMATIC FS600 Parameterization Software LS4soft operating instructions.

11.3 Regular Tests by a Person Qualified and Authorized to Perform the Task

Regular tests must be performed taking into consideration applicable local requirements, especially for guidelines on machines and using work material and work safety guidelines. The purpose of these tests is to discover changes (for example lag times) or manipulations on a machine, vehicle or piece of safety equipment.
To do this, see the checklists under Chapter 11.5 or 11.6

- Have the effectiveness of the safety equipment checked within the required periods, but at least once a year by a trained and knowledgeable person.
- The checklists mentioned above are ideal for regular tests, especially checks for safety-related changes to the machine, the vehicle or the piece of safety equipment.

11.4 Daily Test by with Test Piece Performed by Responsible Operating Personnel

The SIMATIC FS600 Laser Scanner is a safety-oriented laser scanner of Category Typ3. It is extremely important, however, to check the effectiveness of the detection zone with the test piece daily or after a shift change. This ensures that if the parameters or operating mode is changed, the protective function is ensured at every point in the detection zone.

11.4.1 Checklist for Daily Test of Stationary Applications by Responsible Operating Personnel

1)	Are there any problems in the external state of the protective equipment, the cable, cable connections and any command devices or any command devices?	Yes	No
2)	Are the fastening screws in the mounting system firmly connected?	Yes	No
3)	Are the fastening screws in the SIMATIC FS600 Laser Scanner firmly connected?	Yes	No
4)	Are both protective caps (X1 and X2) screwed on and are the firmly in place?	Yes	No
5)	Do the safety equipment and command devices show any safety-relevant changes or gaps in safety (e.g. changes in access possibilities or changes in the surrounding area)?	Yes	No
6)	If the protective function of the SIMATIC FS600 Laser Scanner is present for all required monitoring cases (e.g. testing the switch-off function with a test piece along the detection zone contour, the LED3 for SIMATIC FS600 Laser Scanner must light up with each attempt and the movement that poses a danger must be stopped immediately. Possibility of danger to the person running the test must be excluded)?	Yes	No
7)	Is the startup test/restart interlock (if there is one) working?	Yes	No
8)	Does the base marking match the detection zone contour?	Yes	No
9)	Do the necessary detection zones match the configuration protocol?	Yes	No
10)	If correct functionality is not certain or id the SIMATIC FS600 Laser Scanner LED 5 is flashing, take the machine out of operation immediately. Are any doubts resolved?	Yes	No

If the answer to any of the questions above is No, have the machine checked by a trained specialist.

11.4.2 Checklist for Daily Test of Mobile Applications by Responsible Operating Personnel

1)	Are there any problems in the external state of the protective equipment, the cable, cable connections and any command devices or any command devices?	Yes	No
2)	Are the fastening screws in the mounting system firmly connected?	Yes	No
3)	Are the fastening screws in the SIMATIC FS600 Laser Scanner firmly connected?	Yes	No
4)	Are both protective caps (X1 and X2) screwed on and are the firmly in place?	Yes	No
5)	Do the safety equipment and command devices show any safety-relevant changes or gaps in safety (e.g. by widening the vehicle)?	Yes	No
6)	If the protective function of the SIMATIC FS600 Laser Scanner is present for all required monitoring cases (e.g. testing the switch-off function with a test piece along the detection zone contour, the LED3 for SIMATIC FS600 Laser Scanner must light up with each attempt and the movement that poses a danger must be stopped immediately. Possibility of danger to the person running the test must be excluded)?	Yes	No
7)	Does the vehicle actually stop within the limits defined by the responsible specialist (test of switch-function using a test piece. Is the possibility of danger to the person running the test excluded)?	Yes	No
8)	Is the startup test/restart interlock (if there is one) working?	Yes	No
9)	Do the necessary detection zones match the configuration protocol?	Yes	No
10)	If correct functionality is not certain or id the SIMATIC FS600 Laser Scanner LED 5 is flashing, take the vehicle out of operation immediately. Are any doubts resolved?	Yes	No

If the answer to any of the questions above is No, have the vehicle checked by a trained specialist.

11.5 Checklist for Testing Stationary Applications

The following checklist represents an aid. It helps in, but does not replace the test before the initial startup as well as the regular tests performed by a trained specialist.

1)	Is the mounting position and adjustment of the SIMATIC FS600 Laser Scanner correct and is the possibility of misusing the SIMATIC FS600 Laser Scanner (for example to climb on excluded?	Yes	No
2)	Is the external condition of the additional safety equipment and control devices free of problems?	Yes	No
3)	Are all connection pieces and connection cables in flawless condition?	Yes	No
4)	Are the two safety outputs (OSSDs) connected to the following machine control system in accordance with the corresponding safety category?	Yes	No
5)	Are the following switch elements that are controlled by the SIMATIC FS600 Laser Scanner, for example contactors with forced contacts or safety valves monitored by the feedback loop (EDM)?	Yes	No
6)	Does the actual connection of the SIMATIC FS600 Laser Scanner to the machine control system match the circuit diagrams?	Yes	No
7)	Was the safety distance calculated according to the applicable formulas for safeguarding danger areas and is this minimum distance observed between the detection zone contour and the danger areas?	Yes	No
8)	Is the effect of any potentially reflective surfaces taken into consideration with an addition in the calculation of the safety-related distance? As an alternate solution, have the surfaces been changed (e.g. matted)?	Yes	No
9)	Does the risk assessment take into account the fact that detection zone heights above 300 mm are considered high enough to crawl under in the Standard (EN 999)?	Yes	No
10)	Is access to the danger area only possible through the activated detection zone of the SIMATIC FS600 Laser Scanner in question, or are other entrance or access possibilities safeguarded with suitable safety parts, for example guard fences?	Yes	No
11)	Is the possibility of being between the activated detection zone and the danger area reliably ruled out?	Yes	No
12)	Is an installed protection to prevent walking behind (e.g. undercut) in effect?	Yes	No

13) Is the SIMATIC FS600 Laser Scanner able to cover the entire danger area? Are dead zones excluded?	Yes	No
14) Has the effectiveness of the activated detection zone been tested with the black test piece (70-mm diameter)?	Yes	No
15) Does the base mark match the correctly identified detection zone?	Yes	No
16) Is the start/restart button for resetting the SIMATIC FS600 Laser Scanner positioned according to requirements and does it work properly?	Yes	No
17) Does the SIMATIC FS600 Laser Scanner work in all necessary operating modes and during the entire motion of the machine that is causing a hazard?	Yes	No
18) Is the motion causing the hazard stopped when electrical power to the SIMATIC FS600 Laser Scanner is disconnected and is a confirmation of the Start/restart key necessary to reset the machine after the power is restored?	Yes	No
19) Are all test and parameter inaccessible to unauthorized personnel?	Yes	No
20) Is an identifying sign placed on the machine for the daily test of the SIMATIC FS600 Laser Scanner where it is clearly visible for operating personnel?	Yes	No

11.6 Checklist for Testing Mobile Applications

The following checklist represents an aid. It helps in, but does not replace the test before the initial startup as well as the regular tests performed by a trained specialist.

1)	Is the mounting position and adjustment of the SIMATIC FS600 Laser Scanner correct and is the possibility of misusing the SIMATIC FS600 Laser Scanner (for example to climb on excluded?	Yes	No
2)	Is the external condition of the additional safety equipment and control devices free of problems?	Yes	No
3)	Are all connection pieces and connection cables in flawless condition?	Yes	No
4)	Are the two safety outputs (OSSDs) connected to the following vehicle control system in accordance with the corresponding safety category?	Yes	No
5)	Are the following switch elements that are controlled by the SIMATIC FS600 Laser Scanner, for example contactors with forced contacts or safety valves monitored by the feedback loop (EDM)?	Yes	No
6)	Does the actual connection of the SIMATIC FS600 Laser Scanner to the vehicle control system match the circuit diagrams?	Yes	No
7)	Has the safety distance for safeguarding automatic guided vehicles (AGV) been calculated and observed according to applicable formulas?	Yes	No
8)	Is the effect of any potentially reflective surfaces taken into consideration with an addition in the calculation of the safety-related distance? As an alternate solution, have the surfaces been changed (e.g. matted)?	Yes	No
9)	Does the risk assessment take into consideration the fact that the height of the detection zone must be as low as possible (DIN EN 1525)?	Yes	No
10)	Is an installed protection to prevent walking behind (recessing the SIMATIC FS600 Laser Scanner) in effect?	Yes	No
11)	Has the effectiveness of the activated detection zone been tested with the black test pieces (70-mm diameter standing and 200-mm diameter on their sides)?	Yes	No
12)	Is the start/restart button for resetting the SIMATIC FS600 Laser Scanner positioned according to requirements and does it work properly?	Yes	No

13) Does the SIMATIC FS600 Laser Scanner work in all necessary operating modes and during the entire motion of the vehicle that is causing a hazard? Yes No

14) Is the motion causing the hazard stopped when electrical power to the SIMATIC FS600 Laser Scanner is disconnected and is a confirmation of the Start/restart key necessary to reset the vehicle after the power is restored? Yes No

15) Are all test and parameter inaccessible to unauthorized personnel? Yes No

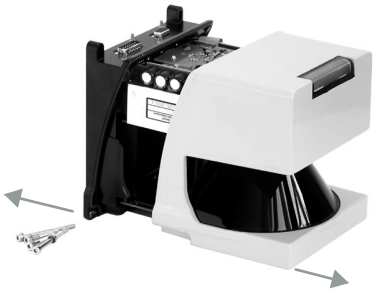
16) Is an identifying sign placed on the machine for the daily test of the SIMATIC FS600 Laser Scanner where it is clearly visible for operating personnel? Yes No

11.7 Replacing the Optical Window

11.7.1 General information:

- Only professionally trained personnel are permitted to replace optical windows.
- Be careful everything stays clean during all jobs. (If possible, work in a dust-free environment. A production hall is not a good place for working on the device).

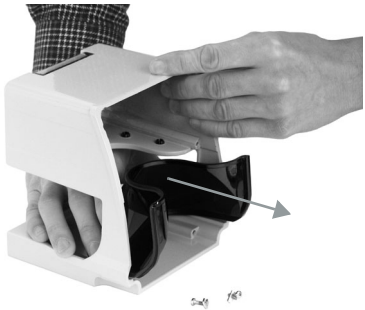
1) Loosening the housing parts



Loosen the four Allen screws on the rear housing wall.
Take the two housing parts carefully apart from each other and place them on a level surface.

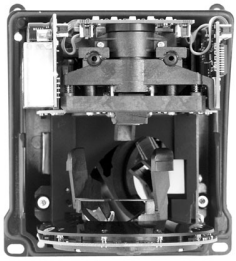
2) Dismounting the optical window

Loosen the screws on the fastening straps.
Remove the fastening straps



Press the old optical window out through the rear (through the housing)

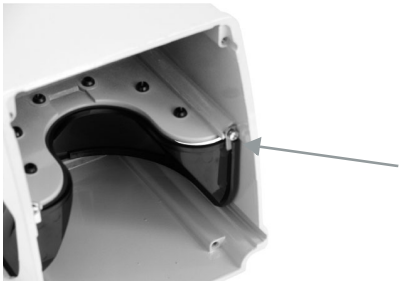
3) Checking the condition of the scanner



Please do not fail to observe:
Check the mirror, optics and housing parts to make certain they are free of dust. Dry if necessary with a dry, oil-free, light jet of compressed air with appropriate components. Do not touch any parts in the device. Avoid leaving fingerprints (grease from fingers may cause the device to function improperly)

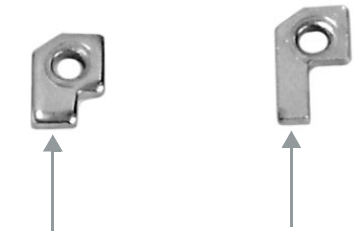
4) Inserting the New Optical Window

Hold the new optical window by the sides and carefully insert it in the correct position, pressing the optical window together slightly as you do so. Make certain the rubber seal is not damaged. Make certain it is in the groove in the housing designed for that purpose.



Check to make sure the optical window is seated correctly. There should be no gap between the optical window and the housing that lets light through.

Find the correct position to avoid a light gap

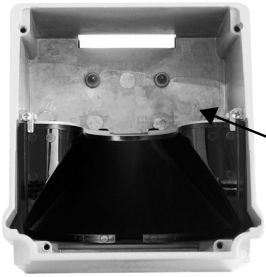


Old fastening strap

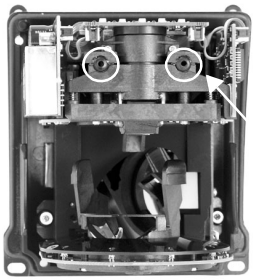
New fastening strap

Then fasten the new optical window in place again with the fastening straps. As you screw in the screws, you can apply a little pressure on the outermost edge of the optical window with your thumbs. The new fastening strap (which has been available since 2002) is the one to use. If an old fastening strap is still installed, please ask for a replacement at no cost with Order No 50040217 from your Service Support Center.

5) Assembling the housing



When assembling the housing, note that the two retaining bolts slide into the rubber sleeves provided for them. To do this, carefully join the two housing parts on a level surface.



After that, carefully screw in the screws on the rear wall of the housing, working back and forth around the circle from screw to screw.
Remove any finger prints on the optical window

11.7.2 Initial Measurement of the New Optical Window

After the optical window has been properly mounted, it is essential to perform a calibration of the optical window. Correct functionality of the scanner cannot be guaranteed without calibrating the optical window!

Please note: The calibration should be performed with an ambient temperature of 20°C - 25°C!

Safety Notes: The optical window (dark red) must be clean and in new condition. Dirty and scratched panes must not be calibrated and used. They would represent a safety risk since the laser light since the laser light would be weakened under some circumstances.

11.7.3 Procedure when Using the SIMATIC FS600 Parameterization Software LS4soft User Software Version 1.09 or later

1) Starting the PCs
2) Connection of X1 (electrical power supply with zone pair activated) and X2 (RS232 cable 1:1)
3) Start SIMATIC FS600 Parameterization Software LS4soft user software
4) Select the “Authorized Customer” authorization level
5) Confirm the echo data shown by the scanner
6) Click on the “Calibrate optical window monitoring” icon under “System data”
7) Start the optical window calibration with “Calibration” (lasts a few seconds, typically with values between 100 - 700).
8) Click on the “Close” button

11.8 Cleaning

11.8.1 Cleaning the Optical Window when Dirty

Different methods will work better under different conditions depending on load and medium. What is the best approach?

Note:
Clean sets 3RG7838-1AA are available for cleaning the optical window. They contain a special cleaning agent and suitable cleaning cloths. Two sizes are available. For more information, see the chapter entitled “Accessories and Spare Parts”.

Please note:
Generally it is sufficient to remove particles relatively quickly moving the cleaning cloth horizontally. If cleaning takes longer (for example because of fingerprints), the scanner will report the fault in optical window monitoring (after cleaning, press “Restart”).

Description	Solution
Particles, loose, abrasive	• Remove with no contact using suction or blow off with oil free air • Wipe clean with a cleaning cloth, wiping in one direction only
Particles, loose, not abrasive	• Suction off with no contact or blow off with oil-free air or • Wipe clean with a cleaning cloth, wiping in one direction only
Particles, adhering	• Wet or moisten the cloth with cleaning agent • Wipe clean with a cleaning cloth, wiping in one direction only
Particles, statically charged	• Suction off with no contact • Wipe clean with cloth moistened in cleaning agent
Particles/drops, greasy	• Wet or moisten the cloth with cleaning agent • Wipe clean with a cleaning cloth, wiping in one direction only
Drops of water	• Wipe clean with a cleaning cloth, wiping in one direction only
Drops of oil	• Wet or moisten the cloth with cleaning agent • Wipe clean with a cleaning cloth, wiping in one direction only
Fingerprints	• Wet or moisten the cloth with cleaning agent • Wipe clean with a cleaning cloth, wiping in one direction only
Scratches	• Replace optical window

11.8.2 Cleaning the Optical Window; Cleaning Diffusing Light Panes

The front and light panes and diffusion screens must be washed depending on the load on the application in question. Generally this is a quick process.

Fig. 11.8-1: Cleaning the Optical Window

Sharp cleaning materials and / cloths that scratch must never be used!

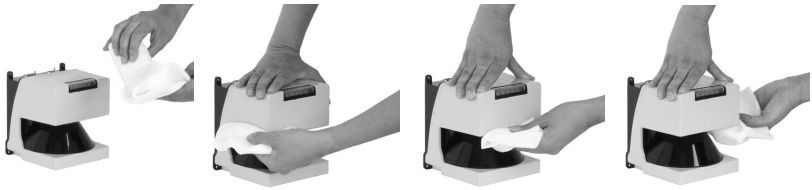


Fig. 11.8-2: Cleaning Diffusing Light Panes

Note:
Dirt can often be eliminated in a work step. If the optical window is cleaned within 4, the scanner is not turned off.

12 Disposal

Laser scanners that are no longer in use must be disposed of in an appropriate manner.

13 Delivery Package

The **basic unit** consists of:

- SIMATIC FS600 Laser Scanner
- Connector X1 MLFB 3RG7838-1BA, complete, 15-pin, interface X1
- Connector X2 MLFB 3RG7838-1CA, complete, 9-pin, interface X2
- Connecting and operating instructions for “SIMATIC FS600 Laser Scanner”, User’s manual for “SIMATIC FS600 Parameterization Software LS4soft”, Configuration and Diagnostic Software “SIMATIC FS600 Parameterization Software LS4soft” on CD-ROM incl. the "SIMATIC FS600 Parameterization Software LS4soft" operating instructions
- Mounting screws, 4 pieces
- Safety notes and guidelines

13.1 Coding of the Control Cable X1

The following table defines the pin assignments for the 12-pin connector cable

Pin No.	Color code	Meaning
1	bk	GND
2	bl	Restart
3	rd	U_B
4	or	FP 1
5	ge	Alarm 1
6	gn	FP 2
7	vio	FP 3
8	gray	FP 4
9	n.c.	
10	n.c.	
11	wh	OSSD 1
12	wh-bk	OSSD 2
13	n.c.	
14	wh-br	
15	br	Alarm 2

Table 13.1-1: Coding of the Control Cable X1

14 Technical data

14.1 Test Pieces

The following test pieces are defined for the purpose of controlling the effectiveness of the monitoring function by the detection zones:

- Cylinder, 500 mm in length, reflectance factor 1.8 % ± 0.2 %, for stationary applications, diameter: 30, 40, 50, 70, 150 mm
- Cylinder, 1000 mm in length, 200 mm in diameter, reflectance factor 1.8 % ± 0.2 %, for mobile systems (e.g. AGV).

14.2 Detection zone

Detection range at a resolution of 30 mm at a resolution of 40 mm at a resolution of 50 mm at a resolution of 70 mm at a resolution of 150 mm	SIMATIC FS620I 4.00 m 4.00 m	SIMATIC FS660I 1.60 m 2.20 m 2.80 m 4.00 m 4.00 m
Reflectance factor	min. 1.8%	
Min. adjustable range	200 mm	
Detection range of test piece from housing	min. 0 mm	
Response time	min. 80 ms (2 scans) adjust. up to 640 ms (16 scans)	
Number of detection zones	4/8 (changeover via switch inputs)	
Output	2 failsafe PNP transistor outputs, 24 V / 250 mA	
Safety category	Requirement class 4 as per DIN V 19250, fail-safe, category 3 as per EN 954-1, Type 3 as per DIN EN 61496-1 and IEC 61496-3, SIL 2 acc. to IEC 61508	
Startup	The startup test and start interlock can be adjusted separately.	
Restart	Automatic or manual, adjustable from 160 ms to 10 s	

Table 14.2-1: Technical Data – Detection Zone

14.3 Detection Zone Additions

Addition with deactivated dust suppression	83 mm
Addition for activated dust suppression	83 mm (for a detection zone size < 3.5 m) 100 mm (for a detection zone size ≥ 3.5 m)
Addition if retro-reflectors or very shiny surfaces such as certain metals or ceramics are present in the scanning plane	0 mm (more than 1.2 m behind the detection zone line) 110 mm (in the detection zone or up to 1.2 m behind detection zone line)

Table 14.3-1: Detection Zone Additions

14.4 Warning zone

Detection range	0 -15 m
Reflectance factor	min. 20 %
Object size	150 x 150 mm
Response time	Double evaluation: 80 ms (corresponds to 2 scans), up to 16 scans can be selected (640 ms)
Number of warning zones	4/8 (selectable via switch inputs)
Output	PNP transistor output, max. 100 mA

Table 14.4-1: Technical data – warning zone

14.5 Contour Measurement

Measurement range	0 - 50 m
Reflectance factor	min. 20 %
Output	Serial interface RS 232 (10 m), RS 422 (50 m)
Radial resolution	5 mm
Lateral resolution	0.36°

Table 14.5-1: Technical data – contour measurement

14.6 Electrical Power Supply

Power supply	+24 VDC +20 % / -30 %, supply according to IEC 742 with safety transformer or comparable for DC/DC converters
Overload protection	Provide by 1.25 A semi-delay fuse in the electronics cabinet
Current consumption	approx. 300 mA (use a power supply with 2.5 A)
Power consumption	8 W at 24 V, plus the output load
Excess voltage protection	Over-voltage protection with safe end cut-off
Voltage drops	In accordance with DIN EN 61496-1
Non-fused ground conductor	Connection not allowed

Table 14.6-1: Technical data – electrical power

14.7 Inputs

Restart/Reset	For connecting a command device for operating mode “with restart interlock” and/or device reset, dynamically monitored, 24 VDC, optically isolated
Zone pair changeover	For selecting among 4 zone pairs via 4 control cables with internal monitoring (zone pair = 1 detection zone and 1 warning zone), 24 VDC, optically isolated
Signal definition High / logical 1 Low / logical 0	 16 ... 30 V < 3 V

Table 14.7-1: Technical data – inputs

14.8 Outputs

Detection zone	2x failsafe semiconductor output, PNP, max. 250 mA, short-circuit monitored, overload protected
Warning zone/dirt/ Fault	2x PNP transistor output, max. 100 mA
Load characteristics, maximum	Low pass behavior, limit frequency f_g = < 1 kHz, $C_{Load} \leq$100 nF
Level high (OSSD active) Level low (OSSD inactive) Level high (alarm active) Level low (alarm inactive)	U_B - 3.2 V < 2.0 V U_B - 4 V < 2.0 V

Table 14.8-1: Technical data – outputs

14.9 Software

User software	Configuration and Diagnostics Software under Windows® 95/98/2000/NT/XP with safe protocol for programming

Table 14.9-1: Technical data – software

14.10 Interfaces

RS 232, RS 422	For device configuration and data exchange

Table 14.10-1: Technical data – interfaces

14.11 Optics

Angle range	max. 190 °
Angle resolution	0.36°
Lateral tolerance without mounting system with mounting system	 ± 0.18° (with respect to the back wall of the housing) ± 0.22° (with respect to the mounting surface)
Scanning rate	25 scans/s or 40 ms/scan
Laser protection class	Class 1, as per EN 60825-1: 1994 + A1: 2002 + A2: 2001 Wavelength: 905 nm Repeat frequency: 25 kHz

Table 14.11-1: Technical data – optics

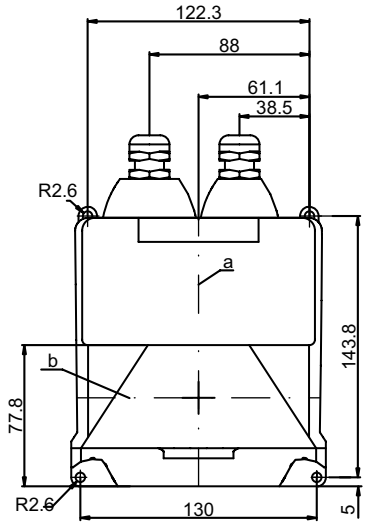
14.12 Environment and Material

Protection type	IP 65 in accordance with IEC 60529
Operating temperature	0 ... + 50 °C
Storage temperature	-20 °C ... + 60 °C
Humidity	DIN 40040 Table 10, Identifying letter E (moderately dry)
Dimensions	140 x 155 x 135 (W x H x D) in mm
Distance from the middle of the scanning plane to the bottom edge of the housing	48.75 mm
Distance from front edge of the housing to the axis of the rotating mirror	64 mm
Connection	2 connectors (plugged in from above)
Control cable length X1	Max. 50 m at a cable cross-section of 0.5 mm^2, shielded Connect shield with PE to the electronics cabinet only
Data cable length X2 RS 232	Max. 10 m
Data cable length X2 RS 422	Max. 50 m (twisted pair)
Housing	Die-cast aluminum, plastic
Weight	Approx. 2 kg
Dynamic stress across 3 axles	In accordance with IEC 60068 Part 2 - 6, 10 – 150 Hz, max. 5 G
Continuous shock across 3 axes	In accordance with IEC 60068 Part 2 - 29, 10 G, 16 ms
Interference immunity	In accordance with DIN EN 61496-1 (corresponds to requirements for type 4); additionally in accordance with DIN 40839-1/3 test pulses 1, 2, 3a, 3b and 5 (not used for vehicles with internal combustion engines)
Rotating mirror drive	Brushless direct-current motor
Rotating mirror bearing	Maintenance-free ball bearing

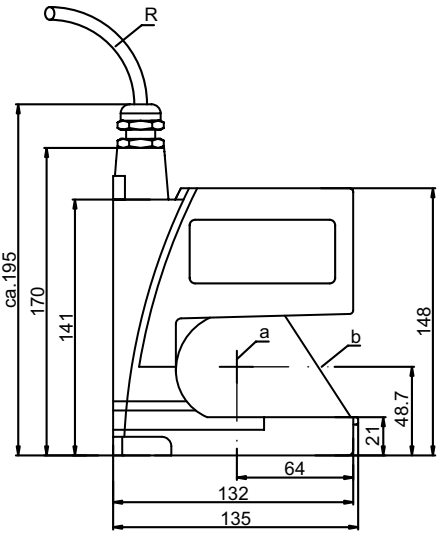
Table 14.12-1: Technical Data on the Environment and Material

14.13 Dimensional drawings of the SIMATIC FS600 Laser Scanner

Front view

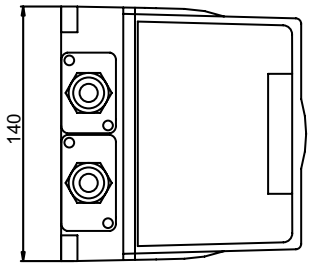


Side view



R = Smallest bending radius = 50 mm (SIEMENS accessory)
d = Axis of the rotating mirror
b = Scanning plane

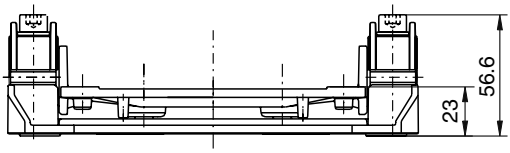
All dimensions given in mm



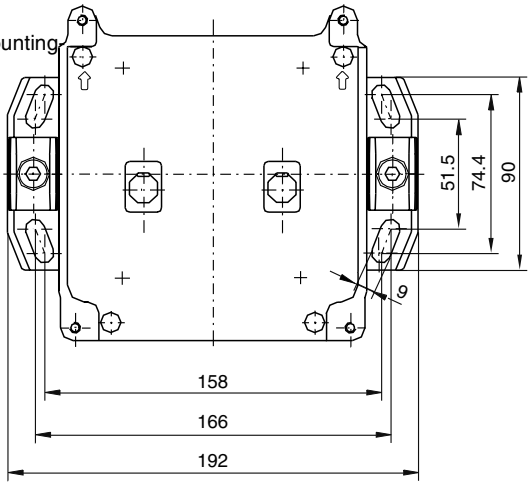
View from above

14.14 Dimensional drawings of the mounting system

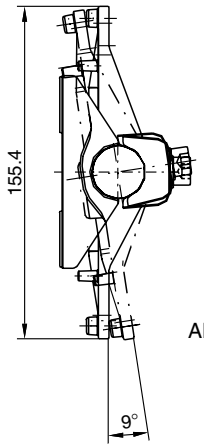
Side view



Scanner mounting surface



Overview of parts



All dimensions given in mm

15 Diagnostic Codes and Causes

Location	Description	No.	Description
102	Processing of commands, processing of messages	2	Data transmission error on the X2 interface
103	Control of command processing	2	Data transmission error on the X2 interface
104	Processing of commands, Processing of configuration	2	Data transmission error on the X2 interface
105	Processing of commands, generation of output messages	6	Function, access, command not permitted with currently selected authorization level
201	Processing of the receive protocol	4	Too much data sent over the X2 interface. Message will be overwritten by new message
302	Processing of the transmit protocol	2	The verification of displayed data remained unacknowledged for too long.
306	Output of measurement values	5	Previous message not yet completely output
801	Event processing	2	Event memory cannot be read, internal fault
805	Processing of the commands to the event memory	6	Event memory cannot be transferred. Data transmission error on interface X2
1002	Motor control during initialization	1	Motor does not reach rated speed after start. Internal fault.
1002	Motor control during initialization	2	Motor speed not constant after start. Internal fault.
1110	Test of the switch outputs.	4	Switch outputs (OSSD) have a state other than the one the scanner expected. Possible wiring or control error
1110	Test of the switch outputs.	5	Switch output (OSSD) cannot be switched off
1110	Test of the switch outputs.	6	Switch output (OSSD) cannot be switched on
1111	Short circuit test of switch outputs	7	Short circuit of a switch output (OSSD) with ground
1111	Short circuit test of switch outputs	8	Short circuit of a switch output (OSSD) with Vcc
1606	Motor speed monitoring	4	Motor speed deviation, zero pulse not detected properly, internal fault
1607	Monitoring of duration of a scan	5	Motor speed deviation, motor not at rated speed

Location	Description	No.	Description
1705	Processing of field monitoring light barrier data	1	Signal of a light barrier in optical window monitoring is under the lower limit. Dirty optical window
1705	Processing of field monitoring light barrier data	2	Signal of a light barrier of optical window monitoring is above the upper limit. Fluid media on the optical window
1906	Test of the external watchdog	1	Watchdog is not enabling the OSSDs. There may be a wiring or control error
1906	Test of the external watchdog	2	Watchdog not switching off the OSSDs. Internal fault
1906	Test of the external watchdog	5	Switch outputs (OSSD) have a state other than the one the scanner expected. Possible wiring or control error
1906	Test of the external watchdog	6	Watchdog not switching the cutoff path for the laser. Internal fault
1907	Test of the external watchdog	4	Event detected by watchdog, watchdog switched off (motor speed deviation), scanner housing may be rotating
1907	Test of the external watchdog	7	Event detected by watchdog, watchdog switched off (motor speed deviation), scanner housing may be rotating
2002	Processing of parameter commands	12	The verification of displayed data remained unacknowledged for too long.
2007	Verification of parameter data received	18	The date of the detection zone currently being transferred is older than the date of the detection zone in the scanner
2201	Area monitoring	5	Number of measurements in the scan too small due to motor speed error or switch-off of the watchdog. Internal fuse faulty
2302	Control of software sequence	1	Error occurred while starting the scanner. Sequential error
2401	Reference measurement on the dark reference element	10	No distance value can be calculated for reference measurement. Glare from another source of light (905 nm) or deviation in motor rotation speed

Location	Description	No.	Description
2401	Reference measurement on the dark reference element	13	No removal value can be calculated for reference measurement. Dust in device because connector housing or dummy connector not screwed on
2402	Reference measurement on the light reference element	10	No distance value can be calculated for reference measurement. Glare from another source of light (905 nm) or deviation in motor rotation speed
2701	Processing of messages for system diagnostics	1	Invalid diagnostic command received. Software and firmware incompatible
2702	Processing of requests for diagnostics data	3	Invalid diagnostic value requested. Software and firmware incompatible
2800	Processing of inputs for detection zone changeover	2	2 detection zones active longer than 1 s
2800	Processing of inputs for detection zone changeover	3	The detection zone changeover that occurred does not correspond to the requirement programmed in the scanner.
2800	Processing of inputs for detection zone changeover	4	More than 2 detection zones selected during operation
2800	Processing of inputs for detection zone changeover	6	Unevaluatable data or defective data quality for activation of detection zone
2800	Processing of inputs during scanner operation	8	No detection zone activated during scanner operation
2801	Test of inputs for detection zone changeover	1	Error during testing of inputs for detection zone changeover, internal fault
2802	Initialization of detection zone changeover	3	The detection zone deactivation that occurred does not correspond to the requirement programmed in the scanner.
2802	Initialization of detection zone changeover	4	More than 2 detection zones selected during Power-On
2802	Initialization of detection zone changeover	6	Unevaluatable data or defective data quality for deactivation of detection zone
2802	Initialization of inputs during power-on	8	No detection zone activated during scanner starting
3016	Monitoring the access authorization with one-time password	11	Confirmed one-time password was entered incorrectly

Table 15.0-1: Diagnostic Codes and Causes

Siemens AG
Automation and Drives
Postfach 48 48
90437 NÜRNBERG
GERMANY

Technical data subject to change 07/07
Siemens AG